Ninety-Ninth Meeting of The Electrochemical Society, Inc.

WASHINGTON, D. C.

April 8, 9, 10, 11, & 12, 1951

LOCAL COMMITTEE

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Ninety-Ninth Meeting

Sunday through Thursday
April 8, 9, 10, 11, and 12

CONDENSED TECHNICAL PROGRAM

Electric Insulation (Abstracts 1-31)

Monday morning, April 9—9:15 A.M.-12:30 P.M.
(Adams-Hamilton Room)
Monday afternoon, April 9—2:00 P.M.-4:30 P.M.
(Adams-Hamilton Room)
Tuesday morning, April 10—9:00 A.M.-12:15 P.M.
(Adams-Hamilton Room)
Tuesday afternoon, April 10—2:00 P.M.-5:00 P.M.
(Adams-Hamilton Room)
Wednesday morning, April 11—9:00 A.M.-12:00 M.
(Adams-Hamilton Room)
Wednesday afternoon, April 11—2:00 P.M.-4:45 P.M.
(Adams-Hamilton Room)
Thursday morning, April 12—9:00 A.M.-11:45 A.M.
(Adams-Hamilton Room)

Electronics—Luminescence (Abstracts 32-56)

Wednesday morning, April 11—9:00 A.M.-12:25 P.M.
(Franklin Room)
Wednesday afternoon, April 11—2:00 P.M.-4:55 P.M.
(Franklin Room)
Thursday morning, April 12—9:00 A.M.-12:20 P.M.
(Franklin Room)
Thursday afternoon, April 12—2:00 P.M.-5:00 P.M.
(Franklin Room)

Electronics—Rare Metals (Abstracts 57-67)

Monday morning, April 9—9:15 A.M.-12:30 P.M.
(Burgundy Room)
Monday afternoon, April 9—2:00 P.M.-4:30 P.M.
(Burgundy Room)

Electronics—Rare Metals and Electrothermics (Abstracts 68-73)

Tuesday morning, April 10—9:00 A.M.-12:00 M.
(Burgundy Room)

Electrothermics (Abstracts 74-93)

Tuesday afternoon, April 10—2:00 P.M.-4:30 P.M.
(Burgundy Room)
Wednesday morning, April 11—9:00 A.M.-11:30 A.M.
(Burgundy Room)
Wednesday afternoon, April 11—2:00 P.M.-4:30 P.M.
(Burgundy Room)
Thursday morning, April 12—9:00 A.M.-12:00 M.
(Burgundy Room)
Thursday afternoon, April 12—2:00 P.M.-5:00 P.M.
(Burgundy Room)

Industrial Electrolytic (Round Table)
Thursday afternoon, April 12—2:00 P.M.-5:00 P.M.
(Adams-Hamilton Room)

Theoretical Electrochemistry (Abstracts 94-120)
Monday morning, April 9—9:15 A.M.-12:25 P.M.
(Franklin Room)
Monday afternoon, April 9—2:00 P.M.-4:05 P.M.
(Franklin Room)
Tuesday morning, April 10—9:00 A.M.-12:30 P.M.
(Franklin Room)
Tuesday afternoon, April 10—2:00 P.M.-4:55 P.M.
(Franklin Room)

GENERAL INFORMATION

Convention Headquarters will be at the **Wardman Park Hotel,** Connecticut Avenue and Woodley Road, Washington, D. C. The registration desk will be in the northeast corner of the Main Lobby.

Rates for rooms will be: single room $5.00 to $9.00; double rooms with twin beds $8.00 to $12.00; parlor, bedroom, and bath—for 1 person $15.00 to $20.00, for 2 persons $18.00 to $22.00; parlor, 2 bedrooms, and bath for 2, 3, or 4 persons $30.00 to $40.00.

There is a garage at the hotel for the convenience of the guests. Rates: $1.25 per day and $5.00 per week.

Requests for room reservations should be made to: Manager, Wardman Park Hotel, Connecticut Avenue and Woodley Road, Washington, D. C. Please use the enclosed hotel reservation card.

Note: In view of the present emergency, the government is increasing its demand for hotel rooms. It is suggested that those who can conveniently do so arrange to share a room. Everyone is advised to make reservations as early as possible so as to insure a better choice of rooms.

REGISTRATION

Registration for members, nonmembers, and ladies will be at separate desks. In order for the nonmembers to take advantage of the Society's offer to extend member registration fees to those making application for membership at that time, applications for membership will be available at the nonmember registration desk.

Members of the AIEE and SPE will be extended the courtesy of registering at the member fee upon showing membership cards.

Registration—Sunday 1:00 P.M. to 6:00 P.M.; Monday through Wednesday 8:00 A.M. to 6:00 P.M.; Thursday 8:00 A.M. to 12:00 M.

The registration fees are:

Members	$6.00	Students	$2.00
Nonmembers	$8.00	Ladies	$2.00
Last day only	$3.00		

Advance registration and purchase of tickets for various functions may be ordered from: Mr. Fielding Ogburn, Electrodeposition Section, National Bureau of Standards, Washington 25, D. C. These will be held at the ticket desk to be picked up in person.

ANNUAL BUSINESS MEETING

The Annual Business Meeting of the Society will be held Monday, April 9th, immediately after the Society luncheon in the same room—Continental Room.

RICHARDS MEMORIAL LECTURE

Dr. J. O'M. Bockris, Department of Chemistry, Imperial College of Science and Technology, London, England, will deliver the Richards Memorial Lecture at 4:30 P.M., Monday, April 9th in the Continental Room. Dr. Bockris is the official delegate of the Faraday Society to this meeting of The Electrochemical Society.

LUNCHEONS AND DINNERS

Monday luncheon—The Society luncheon will be held at 12:30 P.M. in the Continental Room. Dr. E. U. Condon, Director of the National Bureau of Standards, will be the guest speaker. Dr. Condon's topic will be "The Research Program of the National Bureau of Standards." Immediately following the luncheon, the Annual Business Meeting will be held.

Monday buffet supper—The buffet supper will be held in the Burgundy Room starting at 6:30 P.M. This will be followed by a variety entertainment. The remainder of the evening will afford the members the opportunity of renewing old acquaintances.

Tuesday luncheon—There is no general Society luncheon planned at this time. However, the Rare Metals group will hold a luncheon at 12:30 P.M. in the Madison Suite.

Tuesday evening reception and banquet—A reception for President and Mrs. Charles L. Faust will be held at 6:30 P.M. in the Continental Room, following which the Annual Banquet of the Society will be served at 7:15 P.M. Following the dinner, the Young Author's Prize and the Turner Book Prize will be awarded. The featured event will be the Presidential Address, to be delivered by President Faust.

Wednesday luncheon for the Electronics Division at 12:30 P.M. in the Continental Room.

Thursday luncheon and business meeting for the Electrothermic Division in the Continental Room at 12:30 P.M.

LADIES' PROGRAM

A full program is planned for the ladies, consisting of:

Sunday 4:00 to 6:00 P.M.—Informal Tea in the Ladies' Headquarters, the Madison Room.

Monday 1:30 P.M.—Meet in the Madison Room for trip to the National Bureau of Standards for a tour covering research on plastics and textiles, impregnation of leather with rubber, new methods of cutting extremely thin sections of fibers and tissues to be examined in the electron microscope, dental research, and high voltage and x-ray laboratories.

Tuesday 11:15 A.M.—Leave Madison Room for the U. S. Capitol where the ladies will have luncheon in the Senate Dining Room under the sponsorship of Senator Joseph O'Mahoney of Wyoming. This will be followed by a tour of the Capitol and Senate galleries (tickets furnished by Senator O'Mahoney).

Wednesday 9:30 A.M.—Leave Madison Room for a tour of Washington, including the National Art Galleries. Luncheon will be served at the "Old Club Tea House" in Alexandria, Virginia. The tour will continue through Alexandria and to the Mt. Vernon Estate.

TRIPS

Since there are few industrial plants around Washington, no plant trips are scheduled. The National Bureau of Standards is celebrating its semicentennial so arrangements have been made to have one tour a day on Tuesday, Wednesday, and Thursday afternoons. Those desiring to take the tour should indicate the day at time of registration or the day before. Bus will leave the Wardman Park at 1:30 P.M. The tour covers demonstration of the SEAC, the N.B.S. Eastern Automatic Computer; recent developments in electronic instrumentation and printed electronic circuits; high voltage and x-ray laboratories; radio frequency standards; mercury 198 lamps providing a new atomic standard of length; dental research; and the magnetic fluid clutch.

LUNCHEONS AND BUSINESS MEETINGS OF DIVISIONS

Electronics Division—will hold a luncheon and business meeting on Wednesday, April 11th, at 12:30 P.M. in the Continental Room.

Electrothermic Division—will hold a luncheon and business meeting on Thursday, April 12th, at 12:30 P.M. in the Continental Room.

Rare Metals Group—has scheduled a luncheon

for Tuesday, April 10th, at 12:30 P.M. in the Madison Suite.

Theoretical Electrochemistry Division — will hold its annual business meeting and election of officers at 1:30 P.M., Tuesday, April 10th, in the Franklin Room.

BOARD AND COMMITTEE MEETINGS

Sunday 9:00 A.M.—Meeting of the Local Section Advisory Committee in the Franklin Room.

10:30 A.M.—Meeting of the Ways and Means Committee in the Adams Room.

2:00 P.M.—Meeting of the Board of Directors in the Hamilton Room.

Tuesday 1:45 P.M.—Meeting of the Membership Committee in the Caribar Room.

Wednesday 2:00 P.M.—Meeting of the Editorial Staff in the Madison Room.

COST OF VARIOUS FUNCTIONS

(other than registration)

Monday Luncheon (Men)	$ 3.00
Monday Buffet Supper and Entertainment	5.50
Tuesday Division Luncheons	3.00
Tuesday Reception and Banquet	7.00
Wednesday Division Luncheons	3.00
Trip (Men)	.75
Ladies' Functions Complete	10.00

(Gratuities and tax included in the above prices)

REPRINTS

Copies of the January, February, March, and April issues of the JOURNAL OF THE ELECTROCHEMICAL SOCIETY containing some of the papers presented will be available at the Registration desk. The price of single copies of the JOURNAL is $1.00 to members and $1.25 to nonmembers.

DISCUSSION

There will be no recordings made of oral discussions. Those contributing to the discussion of a paper and desiring their remarks published will be supplied with a printed form on which any discussion may be written. These forms may be given to the Secretary-Treasurer of the Division at the end of the session. The discussion will then be referred to the authors for reply. Written discussion will be accepted up to two months following publication of any article in the JOURNAL.

A discussion section is published semiannually in the JOURNAL.

MEETING ROOM SCHEDULE

Meetings	Monday A.M.	Monday P.M.	Tuesday A.M.	Tuesday P.M.	Wednesday A.M.	Wednesday P.M.	Thursday A.M.	Thursday P.M.
Electric Insulation	B	B	B	B	B	B	B	
Electronics—Luminescence					C	C	C	C
Electronics—Rare Metals	A	A	A*					
Electrothermic			A*	A	A	A	A	A
Industrial Electrolytic								B
Theoretical	C	C	C	C				

A—Meeting will be held in the Burgundy Room.
B—Meeting will be held in the Adams-Hamilton Room.
C—Meeting will be held in the Franklin Room.
*The Electronics (Rare Metals) and Electrothermic Divisions will hold a joint session on High Temperature Processes on Tuesday morning.

Technical Program

Monday, April 9, 1951

9:00 A.M.—Formal opening of the 99th Convention with Introduction by General Chairman Paul. L. Howard and Response by President Charles L. Faust.

ELECTRIC INSULATION

Monday, April 9, 1951

The Electrical Properties of Plastics with Dr. John J. Chapman presiding

(ADAMS-HAMILTON ROOM)

This session has been arranged with the cooperation of the **Society of Plastic Engineers.**

9:15 A.M.—**"The Use of Laminates in Electrochemical Industries"** by J. C. Pitzer, The Formica Company, Cincinnati, Ohio. (Abstract No. 1)

10:15 A.M.—**"Dielectric Fatigue of Thermosetting Laminates"** by Norman A. Skow, Sythane Corporation, Oaks, Pa. (Abstract No. 2)

10:45 A.M.—**"The Dielectric Loss in Polyethylene Insulation and the Breakdown of Air at Radio Frequencies"** by Donald L. Birx, Johns Hopkins University, Baltimore, Md. (Abstract No. 3)

11:15 A.M.—**"Properties and Requirements of Plastics for Naval Use"** by Leon L. Deer, U. S. Naval Ordnance Plant, Indianapolis, Ind. (Abstract No. 4)

11:45 A.M.—**"The Effect of Moisture and Fungus upon Electrical Insulating Materials"** by

ELECTRIC INSULATION (cont'd.)

John M. Leonard, Naval Research Laboratory, Washington, D. C. (Abstract No. 5)

12:30 P.M.—Annual Society Luncheon and Business Meeting in the Continental Room.

Electrophysics
with Dr. J. A. Szilard presiding

(ADAMS-HAMILTON ROOM)

2:00 P.M.—**"The Dielectric Heating of Plastics"** by M. P. Vore, Westinghouse Electric Corporation, Baltimore, Md. (Abstract No. 6)

2:30 P.M.—**"The Use of Ultraviolet Radiation in Dielectric Research"** by Harold C. Beachell, University of Delaware, Newark, Del. (Abstract No. 7)

3:15 P.M.—**"The Breakdown of Electrical Insulation at High Frequencies"** by John Dzimianski, Johns Hopkins Institute for Cooperative Research, Baltimore, Md. (Abstract No. 8)

3:45 P.M.—**"Manufacture and Properties of Ozone"** by Clark E. Thorp, Armour Research Foundation, Chicago, Ill. (Abstract No. 9)

4:30 P.M.—**Richards Memorial Lecture** in the Continental Room.

Tuesday, April 10, 1951

Electrolytic Capacitors
with Mr. Ralph A. Ruscetta presiding

(ADAMS-HAMILTON ROOM)

9:00 A.M.—**"A Survey of U.S. Patents Relating to the Electrolytic Capacitor"** by L. W. Foster, R. A. Ruscetta, and S. Sass, General Electric Company, Pittsfield, Mass. (Abstract No. 10)

9:30 A.M.—**"The Electrolytic Capacitor"** by Alexander M. Georgiev, General Motors Corporation, Dayton, Ohio. (Abstract No. 11)

10:15 A.M.—**"Aluminum Foil for Electrolytic Capacitors"** by L. D. Byland and C. J. Hushen, Reynolds Metals Company, Richmond, Va. (Abstract No. 12)

10:45 A.M.—**"A Note on the Nature of Thick Aluminum Oxide Film"** by J. Burnham, G. Green, and P. Robinson, Sprague Electric Company, North Adams, Mass. (Abstract No. 13)

11:30 A.M.—**"Electrolytic Capacitors at Low Temperatures"** by C. D. Crater, Squier Signal Laboratory, Fort Monmouth, N. J. (Abstract No. 14)

12:30 P.M.—**"Glass Fiber Paper Manufacture"**

ELECTRIC INSULATION (cont'd.)

by Bourdon W. Scribner, National Bureau of Standards, Washington, D. C.

A special demonstration of the manufacture of paper made entirely of glass fibers will be made at the National Bureau of Standards Paper Mill, Van Ness and Connecticut Avenues, N. W. The experimental run will last approximately one hour. Buses heading north marked L-2 and L-4 will take the members to the Bureau in five minutes. The run is scheduled at this time to permit interested members to see the demonstration and still attend the afternoon sessions.

Electrolytic Capacitors (cont'd.)
with Mr. Ralph A. Ruscetta presiding

(ADAMS-HAMILTON ROOM)

2:00 P.M.—"Factors Affecting the Measurement of Capacitor Temperature-Coefficient" by John A. Connor, Naval Research Laboratory, Washington, D. C. (Abstract No. 15)

2:30 P.M.—"Some Methods of Measuring the Temperature Coefficient of Capacitors" by David I. Troxel, Naval Research Laboratory, Washington, D. C. (Abstract No. 16)

3:00 P.M.—"Factors Affecting the Leakage of Electrolytic Capacitors" by Gaston Muriset, Standard Telephone et Radio S. A., Zurich, Switzerland. (Abstract No. 17)

3:45 P.M.—"Some Observations on the Theory of Tantalum Electrolytic Capacitors" by N. J. Krilanovich, National Bureau of Standards, Washington, D. C. (Abstract No. 18)

4:15 P.M.—"Tantalum Electrolytic Capacitors for Telephone Plant Use" by R. L. Taylor and M. Whitehead, Bell Telephone Laboratories, Inc., Murray Hill, N. J. (Abstract No. 19)

Wednesday, April 11, 1951

Wires and Cables
with Dr. Ralph Hall presiding

(ADAMS-HAMILTON ROOM)

The sessions on Wires and Cables have been arranged with the cooperation of the **American Institute of Electrical Engineers.**

9:00 A.M.—"The Electrical Properties of Some Liquid Fluorocarbons" by Robert C. Bowers, Naval Research Laboratory, Washington, D. C. (Abstract No. 20)

9:45 A.M.—"Sulfur Hexafluoride—Its Use as an Insulant in High Voltage Equipment" by John F. Gall, Pennsylvania Salt Manufacturing Company, Philadelphia, Pa. (Abstract No. 21)

ELECTRIC INSULATION (cont'd.)

10:30 A.M.—"New Developments in Cables" by J. A. Szilard and J. E. Waters, General Cable Corporation, Bayonne, N. J. (Abstract No. 22)

11:15 A.M.—"Asbestos—Its Preparation, Production, and Fabrication into Electric Insulation" by Jesse M. Weaver, Raybestos-Manhattan Incorporated, Manheim, Pa. (Abstract No. 23)

Wires and Cables (cont'd)
with Dr. Harold C. Beachell presiding

(ADAMS-HAMILTON ROOM)

2:00 P.M.—"Progress in the Field of Magnet Wire" by Ralph Hall, Phelps Dodge Copper Products, Fort Wayne, Ind. (Abstract No. 24)

2:45 P.M.—"Life-Temperature Characteristics of Magnet-Wire Insulation at Elevated Temperatures" by A. T. McClinton, Naval Research Laboratory, Washington, D. C. (Abstract No. 25)

3:15 P.M.—"Glass Fibers—The Effect of Chemical Composition on their Properties" by William M. Temple, Glassfibers Incorporated, Waterville, Ohio. (Abstract No. 26)

4:00 P.M.—"The Determination of the Life of Magnet-Wire Insulation" by E. F. Seaman and Thomas D. Callinan, Navy Department, Washington, D. C. (Abstract No. 27)

Thursday, April 12, 1951

Inorganic and Organic Dielectrics
with Mr. E. F. Seaman presiding

(ADAMS-HAMILTON ROOM)

9:00 A.M.—"The Electrical Properties of Glass-Fiber Paper" by Thomas D. Callinan, Naval Research Laboratory, Washington, D. C. (Abstract No. 28)

9:45 A.M.—" 'Terratex,' A New Material for Spacers and Insulators in Vacuum Tubes" by E. B. Fehr and A. P. Haase, General Electric Company, Schenectady, N. Y. (Abstract No. 29)

10:15 A.M.—"Sources of Muscovite Mica" by James J. Norton, U. S. Geological Survey, Department of the Interior, Washington, D. C. (Abstract No. 30)

11:00 A.M.—"New Casting Resins for Miniaturization" by Clinton Rector, National Engineering Products Company, Washington, D. C. (Abstract No. 31)

ELECTRONICS—LUMINESCENCE

Wednesday, April 11, 1951

with Dr. H. C. Froelich presiding

(FRANKLIN ROOM)

9:00 A.M.—Introductory Remarks.

9:05 A.M.—Keynote Address, **"The Discovery of New Phosphors,"** by Dr. K. H. Butler, Sylvania Electric Products Inc., Salem, Mass.

9:30 A.M.—**"Luminescence of K_2MnCl_4 and KCl (Pb+Mn)"** by Robert J. Ginther, Crystal Branch, Metallurgy Division, Naval Research Laboratory, Washington, D. C. (Abstract No. 32)

9:55 A.M.—**"Calcium Zinc Silicate Phosphor"** by Rudolph Nagy, C. K. Lui Wei, and R. W. Wollentin, Westinghouse Electric Corporation, Bloomfield, N. J. (Abstract No. 33)

10:20 A.M.—**"Manganese Antimonates"** by Virginia M. B. Hannaford and Keith H. Butler, Sylvania Electric Products Inc., Bayside, Long Island, N. Y., and Salem, Mass. (Abstract No. 34)

10:45 A.M.—**"Excitation Spectra of Various Silicate Phosphors"** by Alexander J. Oszy, Sylvania Electric Products Inc., Bayside, Long Island, N. Y. (Abstract No. 35)

11:10 A.M.—**"The Effect of High Energy Radiation on the Absorption and Luminescence of Glasses and Crystals"** by James H. Schulman, Robert J. Ginther, and Clifford C. Klick, Crystal Branch, Metallurgy Division, Naval Research Laboratory, Washington, D. C. (Abstract No. 36)

11:35 A.M.—**"The Thermoluminescence Characteristics of Silicate Phosphors Activated by Manganese and Arsenic"** by C. Bull and G. F. J. Garlick, Physics Department, University of Birmingham, Birmingham, England. (Abstract No. 37)

12:00 M.—**"Particle Formation in Gaseous Discharges"** by Stephen Eros, Lamp Development Laboratory, General Electric Company, Nela Park, Cleveland, Ohio. (Abstract No. 38)

12:30 P.M.—Annual Business Meeting and Luncheon of Electronics Division in the Continental Room.

Electronics—Luminescence (cont'd.)
with Dr. Arthur L. Smith presiding

(FRANKLIN ROOM)

2:00 P.M.—**"The Effect of Temperature on Emission of Fluorescent Lamp Phosphors"** by Charles W. Jerome, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 39)

ELECTRONICS—LUMINESCENCE (cont'd.)

2:25 P.M.—"The Function of Oxygen in Zinc Sulfide Phosphors" by F. A. Kroeger and J. A. M. Dikhoff, Research Laboratories, N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland. (Abstract No. 40)

2:50 P.M.—"Temperature Dependence of Infrared Quenching in ZnS Phosphors" by B. Goldstein and J. J. Dropkin, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (Abstract No. 41)

3:15 P.M.—"Temperature Dependence of the Infrared Stimulability of the SrS:Ce:Sm Phosphor from -195°C to 150° C" by J. J. Dropkin and S. Fischler, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (Abstract No. 42)

3:40 P.M.—"Electrolytic Determination of Cadmium in Zinc Sulfide-Cadmium Sulfide Phosphors" by Robert Bastian, Richard Weberling, and Frank Palilla, Sylvania Electric Products Inc., Kew Gardens, N. Y. (Abstract No. 43)

4:05 P.M.—"Calcium Phosphate Phosphor Activated with Cerium and Manganese" by H. C. Froelich and J. M. Margolis, Lamp Development Laboratory, General Electric Company, Nela Park, Cleveland, Ohio. (Abstract No. 44)

4:30 P.M.—"Absorption, Reflection, Luminescence Emission, and Excitation Measurements with the Beckman Model DU Quartz Spectrophotometer" by Clifford C. Klick and R. G. Stokes, Crystal Branch, Metallurgy Division, and J. G. Schumacher, Engineering Shops Branch, Engineering Services Division, Naval Research Laboratory, Washington, D. C. (Abstract No. 45)

Thursday, April 12, 1951

Electronics-Luminescence (cont'd.)
with Mr. C. W. Jerome presiding

(FRANKLIN ROOM)

9:00 A.M.—"Zinc-Magnesium Oxide and Zinc-Magnesium Sulfide Phosphors" by Arthur L. Smith, Tube Department, Radio Corporation of America, Lancaster, Pa. (Abstract No. 46)

9:25 A.M.—"An Arsenic-Activated Zinc Sulfide Phosphor" by Jerome S. Prener, Research Laboratory, General Electric Company, Schenectady, N. Y. (Abstract No. 47)

9:50 A.M.—"Barium Titanium Phosphate: A New Phosphor" by S. T. Henderson and P. W. Ranby, Thorn Electrical Industries, Limited, London, England. (Abstract No. 48)

ELECTRONICS—LUMINESCENCE (cont'd.)

10:15 A.M.—"Direct Excitation of Phosphors by Electric Fields" by Elmer C. Payne, Eric L. Mager, and Charles W. Jerome, Sylvania Electric Products Inc., Salem, Mass. (Abstract No. 49)

10:40 A.M.—"Saturation and Voltage Effects in Phosphors Excited by Electron Bombardment" by P. H. Dowling and J. R. Sewell, Philips Laboratories, Inc., Irvington on Hudson, N. Y. (Abstract No. 50)

11:05 A.M.—"Excitation Spectra of Calcium Halophosphate" by Alexander J. Oszy and Keith H. Butler, Sylvania Electric Products Inc., Bayside, Long Island, N. Y., and Salem, Mass. (Abstract No. 51)

11:30 A.M.—"Silver as an Activator of Halophosphate Phosphors" by P. W. Ranby, Thorn Electrical Industries Limited, London, England. (Abstract No. 52)

11:55 A.M.—"Luminescent Barium and Magnesium Halophosphates" by J. T. Anderson and R. S. Wells, Research Laboratories, British Thomson-Houston Company, Ltd., Rugby, England. (Abstract No. 53)

Electronics-Luminescence (cont'd.)
with Mr. R. J. Ginther presiding

(FRANKLIN ROOM)

2:00 P.M.—"Copper-Activated Aluminosilicate Phosphors" by Esther W. Claffy and James H. Schulman, Crystal Branch, Metallurgy Division, Naval Research Laboratory, Washington, D. C. (Abstract No. 54)

2:25 P.M.—"Cadmium Chlorophosphate Phosphors" by R. W. Wollentin, C. K. Lui Wei, and Rudolph Nagy, Westinghouse Electric Corporation, Bloomfield, N. J. (Abstract No. 55)

2:50 P.M.—"Luminescence of Three Forms of Zinc Orthophosphate: Mn" by Arthur L. Smith, Tube Department, Radio Corporation of America, Lancaster, Pa. (Abstract No. 56)

3:15 P.M.—Round-table Discussion with Dr. G. R. Fonda presiding.

ELECTRONICS—RARE METALS

Monday, April 9, 1951

Molybdenum

with Mr. Irvin R. Kramer presiding

(BURGUNDY ROOM)

9:15 A.M.—Introductory Remarks.

9:20 A.M.—Keynote Address, **"The Present Technical Position of Molybdenum,"** by Robert Parke, Battelle Memorial Institute, Columbus, Ohio.

9:40 A.M.—**"Effects of Working on the Properties of Molybdenum"** by E. S. Byron and R. F. Baker, Lamp Division, Westinghouse Electric Corporation, Bloomfield, N. J. (Abstract No. 57)

10:05 A.M.—**"The Ductility of Recrystallized Wrought Molybdenum"** by W. E. Few and G. K. Manning, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 58)

10:30 A.M.—**"Brittleness of Recrystalized Molybdenum"** by B. Rightmire and John Wulff, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 59)

11:00 A.M.—**"Some Mechanical Properties of Arc-Cast and Powder-Metallurgy Molybdenum"** by J. H. Bechtold and H. Scott, Research Laboratories, Westinghouse Electric Corporation, Pittsburgh, Pa. (Abstract No. 60)

11:30 A.M.—**"The Rate of Reduction of Tungsten Dioxide by Hydrogen"** by B. Kopelman, C. C. Gregg, and E. P. Larson, Metallurgical Laboratories, Sylvania Electric Products Inc., Bayside, Long Island, N. Y. (Abstract No. 61)

12:00 M.—**"A Thermodynamic Study of the Calcium Reduction Process for Vanadium Metal"** by John C. R. Kelly, Research Department, Westinghouse Electric Corporation, Bloomfield, N. J. (Abstract No. 62)

12:30 P.M.—Annual Society Luncheon and Business Meeting in the Continental Room.

Uncommon Metals

with Dr. Bruce W. Gonser presiding

(BURGUNDY ROOM)

2:00 P.M.—**"The Alloys of Indium with Lead, Tin, Cadmium, and Bismuth"** by R. I. Jaffee and Marguerite G. Weiss, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 63)

2:25 P.M.—**"Recovery of Germanium from Saw-Cutting Wastes"** by V. Ozarow, Electronics Department, General Electric Company, Syracuse, N. Y. (Abstract No. 64)

2:50 P.M.—"Progressive Crystallization Purification of Germanium" by J. P. Jordan, Electronics Department, General Electric Company, Syracuse, N. Y. (Abstract No. 65)

3:15 P.M.—"Electrodesposition of Germanium" by G. Szekely, Physics Laboratories, Sylvania Electric Products Inc., Bayside, Long Island, N. Y. (Abstract No. 66)

3:40 P.M.—"Preparation and Some Properties of Hafnium Metal" by Felix B. Litton, Research and Development Laboratories, The Foote Mineral Company, Berwyn, Pa. (Abstract No. 66a)

4:05 P.M.—"Effect of Pressure on the Refining of Lithium by Distillation" by R. R. Rogers, Chemical Metallurgy Laboratory, Division of Mineral Dressing and Process Metallurgy, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada, and G. E. Viens, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada. (Abstract No. 67)

4:30 P.M.—Richards Memorial Lecture in the Continental Room.

Joint Session

ELECTRONICS—RARE METALS AND ELECTROTHERMICS

Tuesday, April 10, 1951

High-Temperature Processes
with Dr. LaVerne Eastwood presiding

(BURGUNDY ROOM)

9:00 A.M.—"Production of High Temperatures by the Combustion of Metals" by A. V. Grosse and R. Miller, Research Institute of Temple University, Philadelphia, Pa. (Abstract No. 68)

9:30 A.M.—"Fusion Electrolysis Apparatus for the Production of Metal Borides" by S. J. Sindeband, Mercast Corporation, New York, N. Y., and R. P. Seelig, Electro Metal Corporation, Yonkers, N. Y. (Abstract No. 69)

10:00 A.M.—"The Arc Melting of Zirconium Sponge" by H. L. Gilbert, W. A. Aschoff, and W. E. Brennan, II, Bureau of Mines, U. S. Department of the Interior, Albany, Ore. (Abstract No. 70)

10:30 A.M.—"Removal of Embrittling Gases from Zirconium" by W. C. Lilliendahl and E. D. Gregory, Research Department, Westing-

house Electric Corporation, Bloomfield, N. J., and D. M. Wroughton, Westinghouse Atomic Power Division, Bettis Field, Pittsburgh, Pa. (Abstract No. 71)

11:00 A.M.—"Inert Atmosphere Arc Furnaces for Melting Pure Metals with Particular Reference to Titanium" by W. E. Kuhn, Titanium Alloy Manufacturing Division, National Lead Company, Niagara Falls, N. Y. (Abstract No. 72)

11:30 A.M.—"Development of Electrodes for, and Thermal Losses in, the Inert Atmosphere Arc Furnace" by W. E. Kuhn, Titanium Alloy Manufacturing Division, National Lead Company, Niagara Falls, N. Y. (Abstract No. 73)

12:30 P.M.—Luncheon for Rare Metals group in the Madison Suite.

ELECTROTHERMICS

Tuesday, April 10, 1951

High-Temperature Processes (cont'd.)
with Dr. G. M. Butler presiding

(BURGUNDY ROOM)

2:00 P.M.—"Energy Requirements of Electric Furnace Products" by G. R. Finlay, Norton Company, Chippawa, Ontario, Canada. (Abstract No. 74)

2:30 P.M.—"Production of Fused Stabilized Zirconia" by D. W. Marshall, Norton Company, Chippawa, Ontario, Canada. (Abstract No. 75)

3:00 P.M.—"The Relationship of Alpha and Beta Silicon Carbide" by Henry N. Baumann, Jr., Carborundum Company, Niagara Falls, N. Y. (Abstract No. 76)

3:30 P.M.—"Exploration with the High Temperature Microscope" (A Motion Picture) by The Research Staff (through G. M. Butler), The Carborundum Company, Niagara Falls, N. Y. (Abstract No. 77)

Wednesday, April 11, 1951

High-Temperature Materials
with Major R. A. Jones presiding

(BURGUNDY ROOM)

9:00 A.M.—"Refractory Metal Base Super Alloys" by Claus G. Goetzel and Robert L. Pettibone, Sintercast Corporation of America, Yonkers, N. Y. (Abstract No. 78)

ELECTROTHERMICS (cont'd.)

9:30 A.M.—"Vapor Deposition of Metals on Ceramic Particles" by James E. Cline and John Wulff, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 79)

10:00 A.M.—"Refractory Bodies Composed of Boron and Titanium Carbides Bonded with Metals" by James A. Nelson, Tracy A. Willmore, and Raymond C. Womeldorph, Department of Ceramic Engineering, University of Illinois, Urbana, Ill. (Abstract No. 80)

10:30 A.M.—"Design Properties of Cemented Carbide Composition" by John C. Redmond and John W. Graham, Kennametal, Inc., Latrobe, Pa. (Abstract No. 81)

11:00 A.M.—"TiC Base Cermets: Oxidation and Structure Study" by Clinton C. McBride, Engineering Experiment Station, Ohio State University, Columbus, Ohio. (Abstract No. 82)

High-Temperature Materials (cont'd.)
with Mr. Julius Harwood presiding

(BURGUNDY ROOM)

2:00 P.M.—"Thermal Shock Resistance of Brittle Materials, I. General Theory" by H. S. Levine and C. A. Domenicali, The New York State College of Ceramics at Alfred University, Alfred, N. Y. (Abstract No. 83)

2:30 P.M.—"The Fabrication and Properties of Be_2C" by John H. Coobs and Walter J. Koshuba, NEPA Project, Oak Ridge, Tenn. (Abstract No. 84)

3:00 P.M.—"Mechanism of Adherence of Ceramic Coatings to Steel" by W. N. Harrison, Enameled Metals Section, National Bureau of Standards, Washington, D. C. (Abstract No. 85)

3:30 P.M.—"The Zirconia-Yttria System" by Pol Duwez, Frank H. Brown, Jr., and Francis Odell, Department of Mechanical Engineering, California Institute of Technology, Pasadena, Calif. (Abstract No. 86)

4:00 P.M.—"The Development and Testing of High-Temperature Oxide Refractories—Beryllia-Alumina-Titania Porcelains" by S. M. Lang, National Bureau of Standards, Washington, D.C. (Abstract No. 87)

Thursday, April 12, 1951

Measurements of High Temperatures
with Mr. Guy H. Fetterley presiding

(BURGUNDY ROOM)

9:00 A.M.—"Thermocouples for Measuring Temperature up to 4000°F" by Gary Steven,

ELECTROTHERMICS (cont'd.)

Armour Research Foundation, Chicago, Ill. (Abstract No. 88)

9:30 A.M.—"Keeping Industrial Optical Pyrometers in Calibration" by Guy H. Fetterley, Norton Company, Chippawa, Ontario, Canada. (Abstract No. 89)

10:00 A.M.—"Emissivity in Optical Pyrometer Measurements" by R. C. Machler, Leeds & Northrup Company, Philadelphia, Pa. (Abstract No. 90)

10:30 A.M.—"Thermometry by Measurement of Electrical Noise" by J. B. Garrison, Johns Hopkins University, Baltimore, Md. (Abstract No. 91)

11:00 A.M.—"The Measurement of Flame Temperatures" by R. D. Arnold, Heat and Power Division, National Bureau of Standards, Washington, D. C. (Abstract No. 92)

11:30 A.M.—"Maintenance of the High-Temperature Scale at the National Bureau of Standards" by R. J. Corruccini, Heat and Power Division, National Bureau of Standards, Washington, D. C. (Abstract No. 93)

12:30 P.M.—Electrothermic Division Luncheon and Business Meeting in the Continental Room.

Round-Table Discussion
High-Temperature Materials, Methods, and Measurements
with Mr. S. J. Sindeband presiding

This round-table discussion, sponsored by the Electrothermic Division, will begin at 2:00 P.M. in the Burgundy Room.

INDUSTRIAL ELECTROLYTIC DIVISION

Thursday, April 12, 1951

Round-Table Discussion

(ADAMS-HAMILTON ROOM)

2:00-5:00 P.M.—Round-table discussion of requirements for electrochemical products by the defense effort. A panel of experts from Government and industry will lead the discussion.

THEORETICAL ELECTROCHEMISTRY

Monday, April 9, 1951

Electrode Kinetics
with Dr. H. H. Uhlig presiding
(FRANKLIN ROOM)

9:15 A.M.—"The Role of the Cation in the Electrical Double Layer" by David C. Grahame, Moore Laboratory of Chemistry, Amherst College, Amherst, Mass. (Abstract No. 94)

9:45 A.M.—"Studies on Electrode Process of Metals" by R. Piontelli, Polytechnic Institute of Milan, Milan, Italy. (Abstract No. 95)

10:15 A.M.—"Thermodynamics and Kinetics of Electrolytic Deposits Less than a Monoatomic Layer" by M. Haissinsky, Institut du Radium, Paris, France. (Abstract No. 96)

10:45 A.M.—"Electrodeposition Behavior of Traces of Silver, II. Effects of Electrode History and Presence of Other Ions" by John C. Griess, Jr., Oak Ridge National Laboratory, Oak Ridge, Tenn., and John T. Byrne and L. B. Rogers, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 97)

11:05 A.M.—"Electrodeposition Behavior of Traces of Silver, III. Transition Region between 'Trace' and 'Macro' Behavior" by John T. Byrne and L. B. Rogers, Massachusetts Institute of Technology, Cambridge, Mass., and John C. Griess, Jr., Oak Ridge National Laboratory, Oak Ridge, Tenn. (Abstract No. 98)

11:20 A.M.—"Critical Interpretation of Electrodeposition Studies Involving Traces of Elements" by John T. Byrne and L. B. Rogers, Department of Chemistry and Laboratory for Nuclear Science and Engineering, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 99)

11:35 A.M.—"The Electrochemistry of the First Layers of Electrodeposited Metals" by T. Mills and G. M. Willis, Department of Metallurgy, University of Melbourne, Carlton, Victoria, Australia. (Abstract No. 100)

12:00 M.—"Residual Currents" by Edgar Newbery, Department of Physical Chemistry, University of Cape Town, Rondebosch, South Africa. (Abstract No. 101)

12:30 P.M.—Annual Society Luncheon and Business Meeting in the Continental Room.

Electrode Kinetics (cont'd.)
with Dr. H. H. Uhlig presiding
(FRANKLIN ROOM)

2:00 P.M.—"The Anodic Decomposition of Hydrogen Peroxide" by A. Hickling and W. H.

Wilson, Department of Physical and Inorganic Chemistry, University of Liverpool, Liverpool, England. (Abstract No. 102)

2:25 P.M.—"Bright Nickel Plating on Metallic Single Crystals in the Absence of Addition Agent" by Henry Leidheiser, Jr. and Allan T. Gwathmey, Virginia Institute for Scientific Research, Richmond, Va. (Abstract No. 103)

2:50 P.M.—"A Theoretical Study of the Junction between Anodic and Cathodic Polarization Curves and of Mixed Potentials" by Pierre Van Rysselberghe, Department of Chemistry, University of Oregon, Eugene, Ore. (Abstract No. 104)

3:15 P.M.—"The Kinetics of Oxidation-Reduction Electrode Reactions" by J. V. Petrocelli, The Patent Button Company, Waterbury, Conn. (Abstract No. 105)

3:40 P.M.—"Overvoltage at Oxidation - Reduction Electrodes" by J. V. Petrocelli and A. A. Paolucci, The Patent Button Company, Waterbury, Conn. (Abstract No. 106)

4:30 P.M.—Richards Memorial Lecture in the Continental Room.

Tuesday, April 10, 1951

Electrode Kinetics (cont'd.)
with Dr. H. H. Uhlig presiding

(FRANKLIN ROOM)

9:00 A.M.—"The Mechanism of the Hydrogen Evolution Reaction" by J. O'M. Bockris and E. C. Potter, Department of Chemistry, University of London, London, England. (Abstract No. 107)

9:30 A.M.—"Hydrogen Overvoltage from the Kinetic-Thermodynamic Viewpoint" by Hugh W. Salzberg, Naval Research Laboratory, Washington, D. C. (Abstract No. 108)

10:00 A.M.—"Some Factors in Anodic Processes on Corroding Metals" by T. P. Hoar and U. R. Evans, Department of Metallurgy, Cambridge University, Cambridge, England. (Abstract No. 109)

10:30 A.M.—"The Influence of Inhibitors on the Dissolution of Iron in Acid Solution" by J. Elze, Technical University (Institute for Physical Chemistry and Electrochemistry), Berlin-Charlottenburg, Germany, and H. Fischer, Siemens & Halske, Berlin-Siemensstadt, Germany. (Abstract No. 110)

11:00 A.M.—"The Structure of Metal Deposits Obtained by Electrochemical Displacement upon Zinc" by M. E. Straumanis and C. C. Fang, Department of Metallurgy, University of

Missouri, School of Mines and Metallurgy, Rolla, Mo. (Abstract No. 111)

11:30 A.M.—"Phase Boundary Potentials of Silver in Foreign Ion Solutions in the Complete Absence of Air" by J. H. Rosenbaum and D. MacGillavry, Department of Chemistry, Clark University, Worcester, Mass. (Abstract No. 112)

12:00 M.—"Anode Polarization Effects of Nickel in Sulfuric Acid" by Dennis R. Turner, Westinghouse Research Laboratories, East Pittsburgh, Pa. (Abstract No. 113)

1:30 P.M.—Annual Business Meeting of the Theoretical Division in the Franklin Room.

General Theoretical Session
with Dr. H. H. Uhlig presiding

(FRANKLIN ROOM)

2:00 P.M.—"Catalytic Hydrogen-Deuterium Exchange on Different Crystal Faces of Iron" by Ling Yang, Frick Chemical Laboratory, Princeton University, Princeton, N. J. (Abstract No. 114)

2:25 P.M.—"Potentials of Cells with Liquid-Liquid Junctions" by David C. Grahame and J. I. Cummings, Department of Chemistry, Amherst College, Amherst, Mass. (Abstract No. 115)

2:50 P.M.—"Hydrogen Cyanide Detection with the Silver Electrode" by H. H. Roth, Physical Research Laboratory, The Dow Chemical Company, Midland, Mich. (Abstract No. 116)

3:15 P.M.—"The Application of Thermodynamics to Thermogalvanic Data (A Study of the Silver Chloride Electrode from 25° to 100°C)" by Harry Levin and Charles F. Bonilla, Department of Chemical Engineering, Columbia University, New York, N. Y. (Abstract No. 117)

3:40 P.M.—"A Potentiometric Study of the Interaction of Zinc Ions with Sodium Silicates" by J. Fred Hazel, Wallace M. McNabb, and Paul E. Machemer, Department of Chemistry and Chemical Engineering, University of Pennsylvania, Philadelphia, Pa. (Abstract No. 118)

4:05 P.M.—"Production of Ozone with Refrigerated Anodes" by E. I. Lash, R. D. Hornbeck, G. L. Putnam, and E. D. Boelter, University of Washington, Seattle, Wash. (Abstract No. 119)

4:30 P.M.—"The Deposition of Copper Powder with Controlled Cathode Potential" by G. L. Putnam and J. D. Shepard, University of Washington, Seattle, Wash. (Abstract No. 120)

ABSTRACTS

ELECTRIC INSULATION

ABSTRACT NUMBER 1

THE USE OF LAMINATES IN ELECTROCHEMICAL INDUSTRIES

J. C. Pitzer

THE production and application of laminated plastics are discussed with special reference to the problems of the chemical and electrochemical industries. A film illustrating in detail the manufacture of laminated plastics will be presented. The resistance of the materials to chemical corrosiveness and the low dielectric losses of the products are enumerated.

Electrical qualities such as good dielectric strength, low loss factor, and good insulation resistance combined with inherent characteristics as heat resistance, high strength-weight ratio, and low water absorption indicate a variety of applications in which laminates may be of service.

ABSTRACT NUMBER 2

DIELECTRIC FATIGUE OF THERMOSETTING LAMINATES

Norman A. Skow

THERMOSETTING laminates are highly desirable as insulating materials as is shown by their wide acceptance in the electrical industry. The three factors entering into consideration of a material as a dielectric are dielectric strength, dielectric loss, and insulation resistance. Of these, perhaps dielectric strength is the most important, because it depends on many other factors such as temperature, moisture, resistance, and thermal aging. Although much data has been published on the dielectric strength of high pressure laminates, very little information is available on their fatigue properties. When breakdown voltage is plotted against time for breakdown to occur, a limiting voltage is found below which dielectric failure will not occur for an indefinite period of time. Tests of this type yield results which are helpful in the design of insulating components for electrical equipment.

ABSTRACT NUMBER 3

THE DIELECTRIC LOSS IN POLYETHYLENE INSULATION AND THE BREAKDOWN OF AIR AT RADIO FREQUENCIES

Donald L. Birx

BREAKDOWN tests of air between coaxial cylindrical electrodes at 2-18 megacycles and the thermal method of measuring dielectric loss in polyethylene insulation are described.

ABSTRACT NUMBER 4

PROPERTIES AND REQUIREMENTS OF PLASTICS FOR NAVAL USE

Leon L. Deer

The properties of plastics suitable for Navy use are discussed.

ABSTRACT NUMBER 5

THE EFFECT OF MOISTURE AND FUNGUS UPON ELECTRICAL INSULATING MATERIALS

John M. Leonard

AN EVALUATION of the effect of fungi on some of the newer plastics shows that in certain cases the problem has lost the seriousness it once had. The results of intense research on fungicides has also lessened the danger to electronic equipment of fungi attack.

ABSTRACT NUMBER 6

THE DIELECTRIC HEATING OF PLASTICS

M. P. Vore

THE principle of dielectric heating, its characteristics and several industrial uses, and the

probable future trends in industry are elucidated. A sound motion picture illustrating these principles will be shown. Among the materials studied are plastics, rubber, and textiles.

ABSTRACT NUMBER 7

THE USE OF ULTRAVIOLET RADIATION IN DIELECTRIC RESEARCH

Harold C. Beachell

THE failure of electrical insulation has been attributed to chemical, mechanical, and electrical changes in the material as it ages. In order to determine the chemical changes which arise, the infrared and the ultraviolet analyses of the thermally aged dielectric films were undertaken. These studies and the results obtained are reported.

ABSTRACT NUMBER 8

THE BREAKDOWN OF ELECTRICAL INSULATION AT HIGH FREQUENCIES

John Dzimianski

THE author will discuss the results of several years of research upon plastic and ceramic materials. The dielectric breakdown behavior with frequency appears to depend on the chemical structure. Techniques and unusual apparatus will be described.

ABSTRACT NUMBER 9

MANUFACTURE AND PROPERTIES OF OZONE

Clark E. Thorp

THE manufacture and properties of ozone will be presented. A film demonstrating the techniques required and some of the effects obtained will be shown.

ABSTRACT NUMBER **10**

A SURVEY OF U. S. PATENTS RELATING TO THE ELECTROLYTIC CAPACITOR

L. W. Foster, R. A. Ruscetta, and S. Sass

AN ANNOTATED list of 357 patents will be reviewed, covering the last 40 years, giving patent number, date, inventor, and assignee of each patent. Charts are included, giving a breakdown of the patents into (*a*) electrodes, (*b*) electrolytes, (*c*) separators, (*d*) constructional details, and (*e*) circuit arrangements.

ABSTRACT NUMBER **11**

THE ELECTROLYTIC CAPACITOR

Alexander M. Georgiev

THIS paper will include a brief review of developments of electrolytic capacitors during the last twenty years, a discussion on the nature, characteristics, and electrochemical formation of the dielectric film, the electrode, the spacer, container, and the operating characteristics of the electrolytic condenser.

ABSTRACT NUMBER **12**

ALUMINUM FOIL FOR ELECTROLYTIC CAPACITORS

L. D. Byland and C. J. Hushen

SOME of the factors that are considered in the manufacture of aluminum foil for use in the electrolytic capacitor include metal purity, refining procedures, casting methods, and rolling techniques. Annealing cycles are controlled with respect to temperature-time factors so that uniformity of properties and grain size are obtained from run to run. Aluminum of 99.8 per cent purity is susceptible to grain growth at higher annealing temperatures, hence carefully controlled anneals throughout the processing are mandatory.

ABSTRACT NUMBER 13

A NOTE ON THE NATURE OF THICK ALUMINUM OXIDE FILM

J. Burnham, G. Green, and P. Robinson

A RECENT publication from the research laboratories of the Philips Company, in Holland, gives data on the rate of electroforming of an aluminum electrode (which has previously been oxidized in oxalic acid) in boric acid which purports to show that the sizes of the pores in the oxalic film may be estimated from certain measurements. We present evidence that these rates are open to misrepresentation. Furthermore, we show by electron-microscopy that the effect of "sealing" thick oxide film by treatment in boiling water does not fill the pores.

ABSTRACT NUMBER 14

ELECTROLYTIC CAPACITORS AT LOW TEMPERATURES

C. D. Crater

ELECTROLYTIC capacitors currently supplied by leading capacitor manufacturers are severely affected by low temperatures, the degree of degradation being somewhat unpredictable, depending on the manufacturer, voltage rating, characteristic, and different manufacturing lots. This is apparently due to certain variables which are known, but difficult to control, and to others which are not well understood at present. Examples of this type of variable are impurities present in aluminum foil, variation in the etching or forming process, impurities left as the result of etching, and the concentration and type of operating electrolytes.

ABSTRACT NUMBER 15

FACTORS AFFECTING THE MEASUREMENT OF CAPACITOR TEMPERATURE-COEFFICIENT

John A. Connor

THE current practice of attaching a temperature coefficient of capacitance (T-C value) to

a capacitor as a "rated" characteristic leaves considerable room for ambiguity and misunderstanding. Two general concepts of T-C values are used: (1) where capacitance-temperature characteristics are not retraceable and only a maximum T-C value is significant, and (2) where capacitance retrace is expected and a fixed value of T-C can be assigned. Capacitors of the second kind are used as temperature-compensating devices, and must have fairly precise T-C ratings.

ABSTRACT NUMBER 16

SOME METHODS OF MEASURING THE TEMPERATURE-COEFFICIENT OF CAPACITORS

David I. Troxel

ELECTRICAL measurement problems inherent in the measurement of T-C of capacitors are discussed. Three distinct methods are described and related to the basic problems, including the highly stable oscillator or classical technique, the direct substitution method, and third, the slope-comparison method.

ABSTRACT NUMBER 17

FACTORS AFFECTING THE LEAKAGE OF ELECTROLYTIC CAPACITORS

Gaston Muriset

THE paper will deal with the effects of impurities in the foil, the paper, and the electrolytic solution on the final properties of the electrolytic capacitor.

Results will be given on the method of forming and the composition of the electrolytic condenser.

ABSTRACT NUMBER 18

SOME OBSERVATIONS ON THE THEORY OF TANTALUM ELECTROLYTIC CAPACITORS

N. J. Krilanovich

CHARACTERISTICS of tantalum electrolytic capacitors will be discussed in their relation to the theory of solid state electronics.

ABSTRACT NUMBER 19

TANTALUM ELECTROLYTIC CAPACITORS FOR TELEPHONE PLANT USE

R. L. Taylor and M. Whitehead

THE development of tantalum as the electrode material for electrolytic capacitors makes possible capacitors of the electrolytic type in smaller sizes than heretofore available.

The tantalum capacitors are being produced commercially in two types for telephone plant use. The porous type, which is limited as to operating voltage to approximately 60 volts with an electrolyte of lithium chloride, is employed where applicable because of its efficient use of tantalum metal and its smaller size. The foil type, which is constructionally similar to the conventional aluminum electrolytics, is necessary in applications where the operating voltage is higher than the limitations for the porous type.

ABSTRACT NUMBER 20

THE ELECTRICAL PROPERTIES OF SOME LIQUID FLUOROCARBONS

Robert C. Bowers

THE dielectric constant, dielectric loss factor, the insulation resistance, and dielectric strength of selected thermally stable fluorinated compounds were determined over a temperature range of −60° to 140°C. The materials are evaluated in terms of condenser and cable application.

ABSTRACT NUMBER 21

SULFUR HEXAFLUORIDE — ITS USE AS AN INSULANT IN HIGH VOLTAGE EQUIPMENT

John F. Gall

THE commercial availability of sulfur hexafluoride adds another thermally stable inor-

ganic dielectric to the list of materials available to the designer of high voltage transformers and cables. The dielectric, physical, and chemical properties of this synthetic gas are presented and some commercial installations now using the material are evaluated. The usefulness of the material in high voltage equipment is demonstrated.

ABSTRACT NUMBER 22

NEW DEVELOPMENTS IN CABLES

J. A. Szilard and J. E. Waters

PROBLEMS associated with the fabrication and service qualities of cables are presented. Recent requirements for increased heat and flame resistance, low temperature flexibility, resistance to other factors like solvents, chemicals, and ozone are also reviewed. The cable types discussed include rubber, plastic, varnished cambric, paper-oil impregnated cable, and the new mineral-insulated cable.

ABSTRACT NUMBER 23

ASBESTOS — ITS PREPARATION, PRODUCTION, AND FABRICATION INTO ELECTRIC INSULATION

Jesse M. Weaver

THE increase in the military needs and the numerous new uses for asbestos products have made this mineral critical. While there are many sources of asbestos in the United States, few have the qualities of the imported items. The reasons are given and suggestions made for beneficiating native ores. Products made from asbestos of interest to electric insulation specialists are enumerated and evaluated in terms of thermal stability. European developments such as those of dusting, washing, and carding are evaluated.

ABSTRACT NUMBER 24

PROGRESS IN THE FIELD OF MAGNET WIRE

Ralph Hall

DEVELOPMENT in the field of magnet wire insulation and the relationship to savings in the use of electric power are reviewed and evaluated in terms of improved service, life, and savings. The progress in the field is reviewed, and a review of the objectives of the magnet-wire engineer is outlined. Means of evaluating magnet-wire products are given. A brief review of new application techniques and the possibilities of some of the newer materials are indicated.

ABSTRACT NUMBER 25

LIFE-TEMPERATURE CHARACTERISTICS OF MAGNET-WIRE INSULATION AT ELEVATED TEMPERATURES

A. T. McClinton

PRESENT military demands call for the use of insulated magnet wire at temperatures in excess of 300°C. In order to determine how long presently available materials can withstand such temperatures, a series of tests were instituted. In making the evaluation, both mechanical shock and electrical stress were applied to the coils. Some novel results were recorded.

ABSTRACT NUMBER 26

GLASS FIBERS — THE EFFECT OF CHEMICAL COMPOSITION ON THEIR PROPERTIES

William M. Temple

GLASS fibers having tailor-made characteristics are being used in larger quantities by both the military and civilian groups interested in thermally stable dielectrics. The methods by which these fibers are prepared, some of the variety possible in the melt, and the products available, as fiber, yarn, nonwoven and woven fabrics, are presented. Finished products, such as varnished tapes, slot armor, battery separators, and cable wrappings are disclosed.

ABSTRACT NUMBER 27

THE DETERMINATION OF THE LIFE OF MAGNET-WIRE INSULATION

E. F. Seaman and Thomas D. Callinan

THIS is a forum discussing present methods of predicting the life of insulation. By means of question and answer, the views of the engineer-in-the-field are compared with those of the research engineer, in an effort to determine both a theoretical and a practical basis for accelerated aging tests. Insulation resistance, withstand-voltage, abrasion resistance, and tensile tests data are reviewed critically. It is demonstrated that while each has a definite service life relationship, a constant which relates the electrical, mechanical, and chemical properties is required.

ABSTRACT NUMBER 28

THE ELECTRICAL PROPERTIES OF GLASS-FIBER PAPER

Thomas D. Callinan

THE dielectric constant, dielectric loss and power factor, insulation resistance, and dielectric strength of unimpregnated and impregnated paper made entirely from glass fibers are presented. The mechanical properties of the varnished papers which can be prepared from the 100 per cent glass sheet are enumerated. The results of fabricating the paper into oil impregnated condensers are given.

ABSTRACT NUMBER 29

"TERRATEX," A NEW MATERIAL FOR SPACERS AND INSULATORS IN VACUUM TUBES

E. B. Fehr and A. P. Haase

MICA is used predominantly for spacing and insulating metal parts in vacuum tubes. A new material has been developed for this purpose using asbestos sheet as a base. Special processing is required to obtain proper mechanical characteristics and freedom from gas and vapors

which are harmful to cathode emission. A comparison between mica and Terratex shows the latter's advantages in terms of cost, availability, and ease of fabrication. Insulating properties compare favorably with mica; in particular, surface conductivity is reduced due to the relatively rough surface. This eliminates need for insulating spray coating frequently required with mica. Mechanical properties of the Terratex spaces differ considerably from mica. This results in certain advantages with respect to tube noise and microphonics, but limits the usefulness of Terratex in other cases.

ABSTRACT NUMBER 30

SOURCES OF MUSCOVITE MICA

James J. Norton

SHEET and scrap muscovite mica are mined from a coarse-grained granitic rock called pegmatite, and are obtained from pegmatite units that are rich in large crystals of muscovite. In addition, scrap mica is produced as a by-product of mining for other pegmatite minerals. The physical characteristics, chemical composition, electrical properties, and, consequently, the usability of mica differ from one pegmatite to another and from one unit to another, within the same pegmatite period.

The chief domestic sources of mica are in the southeastern states, New England, and South Dakota. Most sheet mica comes from foreign countries, principally India and Brazil where the large amount of hand labor required for mining and especially for processing can be obtained cheaply.

ABSTRACT NUMBER 31

NEW CASTING RESINS FOR MINIATURIZATION

Clinton Rector

MINIATURIZATION has placed new demands on the plastics industry to develop casting resins of exceptional dielectric qualities. A number of such items possessing high dielectric strength, exceptional moisture resistance, and good thermal stability have been developed. These materials are now available commercially,

and have been found to possess excellent shelf-life and relative ease in handling. They set to hard, bubble-free products with a minimum of detail. Outstanding are their low shrinkage and their high resistance to corrosive chemicals.

ELECTRONICS—LUMINESCENCE

ABSTRACT NUMBER 32

LUMINESCENCE OF K_4MnCl_6 AND KCl (Pb + Mn)

Robert J. Ginther

EXCITATION and emission spectra of K_4MnCl_6 and KCl (Pb + Mn) are reported. A method for the preparation of K_4MnCl_6 from solution at room temperature is described. Lead and thallium are shown to produce sensitized luminescence in this phosphor.

ABSTRACT NUMBER 33

CALCIUM ZINC SILICATE PHOSPHOR

Rudolph Nagy, C. K. Lui Wei, and R. W. Wollentin

SUBSTITUTION of zinc for calcium in lead-activated calcium silicate phosphor shifted the peak of emission from 3300 Å to 3450 Å. X-ray analysis indicated that the new phosphor had a tetragonal structure similar to mineral Hardystonite instead of Wollastonite, the triclinic configuration of calcium silicate. This phosphor, when made into "black-light" fluorescent lamps, gave outputs comparable to the best calcium cerium phosphate phosphor.

ABSTRACT NUMBER 34

MANGANESE ANTIMONATES

Virginia M. B. Hannaford and Keith H. Butler

THE preparation of two antimonates of manganese is described and x-ray powder diffraction data are given. The results are compared with data by previous investigators. Some pre-

liminary data are also given for a fluoantimonate of manganese and calcium and a fluoantimonate of manganese. The firing of calcium halophosphate phosphors produces some of these compounds as intermediates. The reaction mechanism of the formation of the phosphor is discussed briefly with reference to the behavior of manganese.

ABSTRACT NUMBER 35

EXCITATION SPECTRA OF VARIOUS SILICATE PHOSPHORS

Alexander J. Oszy

NEW data are presented on the excitation spectra of various silicate phosphors using a calibrated hydrogen arc for the excitation of fluorescence. Phosphors measured include the system $ZnBeSiO_4$:Mn with varying Mn content and varying Zn to Be ratio.

ABSTRACT NUMBER 36

THE EFFECT OF HIGH ENERGY RADIATION ON THE ABSORPTION AND LUMINESCENCE OF GLASSES AND CRYSTALS

James H. Schulman, Robert J. Ginther, and Clifford C. Klick

THE absorption of radiant energy by matter can result in dissipation of the absorbed energy as heat, in re-radiation of the absorbed energy as luminescence, or in production of photochemical changes in the absorbing material. The occurrence of photochemical changes on irradiation of a solid is most frequently manifested by a change in its absorption spectrum, as, for example, in the formation of F-bands by treatment of the alkali halides with x-rays or gamma-rays. A number of crystals and glasses are of particular interest, in that they undergo photochemical changes, on exposure to high energy radiation, that alter not only their absorption spectra but their luminescent properties as well. The behavior of a number of such crystalline and glassy systems will be described, and an interpretation of the phenomenon will be proposed for some of the simpler cases.

ABSTRACT NUMBER **37**

THE THERMOLUMINESCENCE CHARACTERISTICS OF SILICATE PHOSPHORS ACTIVATED BY MANGANESE AND ARSENIC

C. Bull and G. F. J. Garlick

A QUANTITATIVE investigation has been made of the effect of inclusions of arsenic on the thermoluminescence characteristics of various manganese-activated silicate phosphors. It is found that the complex distributions of the thermal activation energies of the electron trapping states in Zn_2SiO_4–Mn, $(ZnBe)_2SiO_4$–Mn, $CdSiO_3$–Mn, and $(ZnCd)_2SiO_4$–Mn phosphors are greatly modified by small inclusions (1 in 10^5) of arsenic, and that in all cases the total number of electron traps is greatly increased. Other silicate systems, notably $SrSiO_3$–Mn, $BaSiO_3$–Mn, and $CaSiO_3$–Mn, do not show this effect.

ABSTRACT NUMBER **38**

PARTICLE FORMATION IN GASEOUS DISCHARGES

Stephen Eros

THE effects of clouds of fine particles in gaseous discharges are discussed briefly, as well as simple means for studying them. The major part of the paper is concerned with the reactions leading to the formation of particles.

ABSTRACT NUMBER **39**

THE EFFECT OF TEMPERATURE ON EMISSION OF FLUORESCENT LAMP PHOSPHORS

Charles W. Jerome

EXPERIMENTS are described determining the effect of temperature on the emission bands of fluorescent lamp phosphors. Results are given verifying the validity of the assumptions made by Keith H. Butler in his development of the

theory for this effect as presented in his paper, "Fluorescence of Silicate Phosphors, III. Application of Potential Energy Curves," *J.* (*and Trans.*) *Electrochem. Soc.*, **95**, 267 (1949).

ABSTRACT NUMBER **40**

THE FUNCTION OF OXYGEN IN ZINC SULFIDE PHOSPHORS

F. A. Kroeger and J. A. M. Dikhoff

AT 1200°C ZnS and ZnO form a limited range of solid solutions resulting in new absorption and fluorescence bands of ZnS. The effects are explained with the assumption of separate oxygen levels and of new centers consisting of associated pairs of oxygen and activator ions formed according to the principle of compensation of volume. This principle also explains the benefit of oxygen on the intensity of fluorescence, and appears as the logical completion of the principle of compensation of charge introduced earlier.

ABSTRACT NUMBER **41**

TEMPERATURE DEPENDENCE OF INFRARED QUENCHING IN ZnS PHOSPHORS*

B. Goldstein and J. J. Dropkin

THE efficiency and rate of quenching of fluorescence under 3650Å in Zns:Cu:(Co, Fe, Ni, or Mn) phosphors by infrared has been investigated from 25°C to 250°C at various levels of ultraviolet and infrared intensity for both the 7800 Å and the 13,200 Å quenching bands. The infrared quenching efficiency curves were compared to the fluorescence efficiency curves. The curves are similar for cobalt and differ for the other quenching activators. The shape of the curves is relatively insensitive to intensity changes. The time to reach 60 per cent of the final quenching value under infrared is a maximum at 110°C for cobalt-activated phosphors. No such minimum rate of quenching is found for the other activators. A tentative explanation for these effects is offered in terms of Klasens' theory of temperature quenching, and the position of the activator levels in an energy band scheme.

* This work was supported in part by the U. S. Army Signal Corps, Project W 36-039 Sc 38198.

ABSTRACT NUMBER **42**

TEMPERATURE DEPENDENCE OF THE INFRARED STIMULABILITY OF THE SrS:Ce:Sm PHOSPHOR FROM —195°C TO 150°C*

J. J. Dropkin and S. Fischler

THE infrared stimulability of the Standard VII (SrS:Ce:Sm) phosphor, excited with 3650 Å at various temperatures, has been measured in the temperature range —195°C to 150°C with as little change in the state of excitation of the phosphor as possible by means of short bursts of low intensity infrared. The stimulability was very low at —195°C, rose to a maximum at about 0°C, and showed a subsidiary but sharp maximum at 50°C. The existence of these maxima indicates thermally-activated steps in the stimulation process. Differences between the stimulability curves for excitation at different temperatures indicate similar thermal steps in the excitation process.

* This work was supported in part by the U. S. Army Signal Corps, Project W 36-039 Sc 38198.

ABSTRACT NUMBER **43**

ELECTROLYTIC DETERMINATION OF CADMIUM IN ZINC SULFIDE-CADMIUM SULFIDE PHOSPHORS

Robert Bastian, Richard Weberling, and Frank Palilla

A RAPID electrolytic method for determining cadmium in zinc sulfide-cadmium sulfide phosphors is presented. From 0.2 to 0.7 g of cadmium is plated from a sulfuric acid, potassium bisulfate solution containing up to 3 grams of zinc. Cadmium deposition is not quite complete but the amount remaining in solution is so nearly constant that a correction can be made for it. When this is done an average accuracy and precision of about one part per thousand is obtained.

ABSTRACT NUMBER **44**

CALCIUM PHOSPHATE PHOSPHOR ACTIVATED WITH CERIUM AND MANGANESE

H. C. Froelich and J. M. Margolis

THE useful deep red emission of $Ca_3(PO_4)_2$: (Ce, Mn) phosphors is obtained over a fairly wide range of activator concentrations. The ratio of sensitizer to principal emitter atoms is one or two orders of magnitude larger than in most sensitized phosphors. Partial substitution of Ca by other elements, and excitation at higher temperatures, lead to shifts in peak emission toward orange and to improved temperature stability of the phosphors, notably those with sodium. An optimum effect is obtained with a mole ratio of Na:Ce = 1:2, while Kroeger's simple theory of stabilization would require 1:1.

ABSTRACT NUMBER **45**

ABSORPTION, REFLECTION, LUMINESCENCE EMISSION, AND EXCITATION MEASUREMENTS WITH THE BECKMAN MODEL DU QUARTZ SPECTROPHOTOMETER

Clifford C. Klick, R. G. Stokes, and J. G. Schumacher

MODIFICATIONS of the Beckman Model DU Spectrophotometer are described which allow it to record continuously emission and excitation spectra of luminescent materials as well as reflection of powders and transmission of solids by point-by-point methods. All the measurements can be made over the wavelength range of 2200 Å to 7000 Å. Performance of the instrument is illustrated by measurements made on a thallium-activated potassium chloride phosphor.

ABSTRACT NUMBER **46**

ZINC-MAGNESIUM OXIDE AND ZINC-MAGNESIUM SULFIDE PHOSPHORS

Arthur L. Smith

THE luminescent properties of the solid solutions formed by the addition of magnesium oxide to zinc oxide and magnesium sulfide to zinc sulfide have been briefly investigated. In general, peak emissions are shifted to shorter wavelengths. Zinc-magnesium oxide has its peak at 4800 Å as compared to 5050 Å for zinc oxide alone. Silver- and copper-activated sulfides con-

taining magnesium show a shift of about 150 Å toward shorter wavelength when compared to zinc sulfide alone, and the copper-activated materials have longer cathodoluminescent-induced phosphorescence. Activators such as arsenic, antimony, and bismuth may be used in the mixed matrix, whereas in zinc sulfide alone they function only feebly.

ABSTRACT NUMBER 47

AN ARSENIC-ACTIVATED ZINC SULFIDE PHOSPHOR

Jerome S. Prener

THE addition of small amounts of arsenic to zinc sulfide produces a phosphor which has three emission bands when excited by ultraviolet or cathode rays. The blue band at about 4650 Å is the one that is also present in unactivated zinc sulfide phosphors. The other two bands at 5200 Å and 6200 Å are due to the presence of arsenic.

The relative intensity of the various bands depends on the concentration of arsenic, the atmosphere in which the phosphor was fired, the mode of excitation, and the temperature during excitation. By a proper adjustment of the arsenic concentration, it is possible to produce phosphors which emit white light.

ABSTRACT NUMBER 48

BARIUM TITANIUM PHOSPHATE: A NEW PHOSPHOR

S. T. Henderson and P. W. Ranby

THE preparation of a new phosphor is described: barium pyrophosphate containing about 30 molar per cent of titanium dioxide but no other addition. The mechanism of its formation has been examined by differential thermal analysis and by x-ray diffraction, but the structure has not yet been fully elucidated. Its luminescent properties are similar in many respects to those of magnesium tungstate, for which it is a useful substitute in fluorescent lamps. It has short afterglow, high efficiency, good maintenance in the mercury discharge, and an emission band extending through the whole visible spectrum with a peak at 4835 Å.

ABSTRACT NUMBER 49

DIRECT EXCITATION OF PHOSPHORS BY ELECTRIC FIELDS

Elmer C. Payne, Eric L. Mager, and Charles W. Jerome

ELECTRICAL energy is converted directly into light by the action of a fluctuating electric field upon a suitable solid. The luminophor is embedded in a dielectric and the device may be considered as a luminous capacitor. Light output increases with the potential and the frequency of the applied field and with the dielectric constant of the dielectric. The light emitted is sufficiently intense for practical use and a number of applications have been developed. Light sources embodying this principle constitute luminous areas and as such are a useful supplement to the point and line sources presently available.

ABSTRACT NUMBER 50

SATURATION AND VOLTAGE EFFECTS IN PHOSPHORS EXCITED BY ELECTRON BOMBARDMENT

P. H. Dowling and J. R. Sewell

AN ATTEMPT is made to correlate quantitatively saturation, voltage effects, absolute efficiency, and activator concentration in phosphors excited by electron bombardment. The calculations lead to the ideas that there is a dead layer some 150 Å thick on the surface of the phosphor and that the primary electron beam loses energy exponentially with distance as it travels into the phosphor.

ABSTRACT NUMBER 51

EXCITATION SPECTRA OF CALCIUM HALOPHOSPHATE

Alexander J. Oszy and Keith H. Butler

NEW data on the ultraviolet excitation spectrum of calcium halophosphates have been obtained. A calibrated hydrogen arc was used to provide the exciting radiation, and the fluorescent output was measured with a filter photocell com-

bination. Phosphors with a wide range of manganese contents were measured at various ratios of chloride to fluoride.

ABSTRACT NUMBER **52**

SILVER AS AN ACTIVATOR OF HALOPHOSPHATE PHOSPHORS

P. W. Ranby

IT HAS been found that the alkaline earth halophosphates can be activated by silver; manganese can be incorporated as an additional activator. These phosphors show a number of differences from previously known halophosphate phosphors activated, for example, by antimony. The properties of the silver-activated phosphors are described and compared with those of other halophosphate phosphors. An explanation, based on the position of silver in the halophosphate lattice, is suggested to account for the differences between silver- and antimony-activated halophosphate phosphors.

ABSTRACT NUMBER **53**

LUMINESCENT BARIUM AND MAGNESIUM HALOPHOSPHATES

J. T. Anderson and R. S. Wells

A SHORT account is given of the preparation and luminescent spectral emissions of the halophosphates of barium and magnesium. The uranium-activated material, in each case, can be made to give a response to a wide range of ultraviolet radiation.

ABSTRACT NUMBER **54**

COPPER-ACTIVATED ALUMINOSILICATE PHOSPHORS

Esther W. Claffy and James H. Schulman

A NEW system of blue-luminescing, copper-activated aluminosilicate phosphors, corresponding to the general formula $x(yM_2^{I}O, zM^{II}O)$·

$pAl_2O_3 \cdot qSiO_2$, is reported. These phosphors can be synthesized from any combination of group IA and group II metals, and they can tolerate a wide variation in the quantities of all the oxide components, including the copper activator.

Excitation and emission spectra are included for several typical phosphors, showing the relatively slight effects of variation in composition. The major excitation peak is in the neighborhood of 2600 Å. The emission spectra resemble that of $CaWO_4$, although the luminescence is slightly "whiter" and only one-third as bright. The luminescence efficiency of these phosphors is nearly independent of temperature up to 115°C, at which temperature their brightness is equal to that of $CaWO_4$.

ABSTRACT NUMBER **55**

CADMIUM CHLOROPHOSPHATE PHOSPHORS

R. W. Wollentin, C. K. Lui Wei, and Rudolph Nagy

AN INVESTIGATION of cadmium chlorophosphate phosphor has been undertaken to determine the possibilities of its use in the production of fluorescent lamps. Under 2537 Å excitation, this phosphor fluoresces a yellowish pink with a peak of emission at 5900 Å. Studies were made of the effect of substitutions of a number of various cations for cadmium on the output, emission, excitation, and interlattice spacing of the phosphor. Acceptable commercial lamps can be made with a number of modifications of cadmium chlorophosphate.

ABSTRACT NUMBER **56**

LUMINESCENCE OF THREE FORMS OF ZINC ORTHOPHOSPHATE: Mn

Arthur L. Smith

THREE forms of zinc orthophosphate:manganese have been found. The α form corresponds in x-ray diffraction pattern to the published values. The luminescence is green, the peak wavelength being 5540 Å. It is produced when manganese concentrations are below 1 mole per cent, or when higher concentrations are not heated above 700°C. The β form has a red luminescence with a peak at 6380 Å. This formation occurs at manganese concentrations above 1 mole per cent and firing temperatures above 800°C. The

form may be produced by additions of magnesium orthophosphate above 3 mole per cent. The emission is similar to the β form with a peak at 6320 Å, and of somewhat lowered intensity.

ELECTRONICS—RARE METALS

ABSTRACT NUMBER **57**

EFFECTS OF WORKING ON THE PROPERTIES OF MOLYBDENUM

E. S. Byron and R. F. Baker

HEAT-TREATED, unworked molybdenum made by powder metallurgy process has an ultimate strength of about 60,000 to 70,000 psi and an elongation of usually less than 1 per cent. Upon rolling or forging at suitable temperatures, however, the strength increases and, under some conditions, the ductility is greatly improved in the direction of the metal flow brought about by the working. The hardness during working is increased more or less equally in all three axial directions but there is little improvement in strength or ductility in the compressive direction, that is, the direction in which flow does not take place.

ABSTRACT NUMBER **58**

THE DUCTILITY OF RECRYSTALLIZED WROUGHT MOLYBDENUM

W. E. Few and G. K. Manning

IT HAS been found that wrought molybdenum wires are extremely brittle when quenched from 3800°F, but ductile if cooled slowly. Reheating the quenched wires within the temperature range of 2000°F to 3500°F also restores the ductility. The mechanism causing these differences is not fully understood. Studies are in progress which attempt to link the varying ductility with small changes in chemical composition.

ABSTRACT NUMBER **59**

BRITTLENESS OF RECRYSTALLIZED MOLYBDENUM

B. Rightmire and John Wulff

FROM tensile test studies on polycrystalline molybdenum annealed and tested in controlled atmospheres, it was found that single crystal molybdenum wire is stronger and more ductile than room-temperature fully-annealed polycrystalline wire. At 300°C both exhibit ductile fracture, but the polycrystalline material is stronger. Auxilliary studies using molybdenum of different purity and heat-treatments in different atmospheres indicate that the above mechanical behavior may be attributed more readily to grain boundary precipitates than to texture.

ABSTRACT NUMBER **60**

SOME MECHANICAL PROPERTIES OF ARC-CAST AND POWDER-METALLURGY MOLYBDENUM

J. H. Bechtold and H. Scott

HAVING found that molybdenum can be so wrought and annealed as to have high ductility as fully recrystallized, an effort was made to make a comparison in this preferred condition of one lot of molybdenum as consolidated by powder metallurgy methods with another lot consolidated from powder by arc-casting. The results show very little difference between these products in either tensile properties determined over a range of temperatures above and below atmospheric or in creep strength at 1600°F. Particularly significant is the finding of a well-defined transition between ductile and brittle fracture on tensile test at a temperature only slightly below atmospheric which is similar to that occurring in iron at lower temperatures.

The fine-grained, fully recrystallized condition in pure molybdenum is unfavorable to creep strength as it is known to be in other pure metals, but its creep strength is remarkably high relative to other pure metals of lower melting point and even to alloys of the same.

ABSTRACT NUMBER **61**

THE RATE OF REDUCTION OF TUNGSTEN DIOXIDE BY HYDROGEN

B. Kopelman, C. C. Gregg, and E. P. Larson

THE rate of reduction of tungsten dioxide to metal by hydrogen has been determined in the

temperature range 725-900°C as a function of hydrogen flow.

This reduction is unique among oxides reducible to metal by hydrogen in that the rate of reduction is determined solely by the rate of flow of reducing gas and is not affected by the metal product formed nor by the diffusion of hydrogen into the particles, nor of water vapor out of the particles.

The activation energy for this reduction is found to be 34,600 calories.

ABSTRACT NUMBER 62

A THERMODYNAMIC STUDY OF THE CALCIUM REDUCTION PROCESS FOR VANADIUM METAL

John C. R. Kelly

EACH step in the production of ductile vanadium metal by the calcium reduction of the trioxide is analyzed with respect to the thermochemical factors influencing the nitrogen and oxygen content of the end product. The nitrogen equilibria in the two reduction steps, pentoxide to trioxide and trioxide to metal, are discussed. Predictions are substantiated, where possible, by analytical findings and physical tests.

ABSTRACT NUMBER 63

THE ALLOYS OF INDIUM WITH LEAD, TIN, CADMIUM, AND BISMUTH

R. I. Jaffee and Marguerite G. Weiss

THE most useful alloys containing indium for industrial application in bearings, solder, low-fusing alloys, etc., are those with indium's four sister elements: lead, tin, cadmium, and bismuth. Data are presented on the mechanical properties of the binary alloys of indium with these elements. These include hardness, tensile strength, and compressive strength. Also data are presented on some of the applications of these alloys as solders for glass-metal joints and as electrical fuse elements.

ABSTRACT NUMBER 64

RECOVERY OF GERMANIUM FROM SAW-CUTTING WASTE

Vernon Ozarow

A PROCEDURE for recovering pure germanium from saw-cutting waste using known chemical reactions has been developed. The waste, comprised of germanium, glass, and a small amount of sealing wax, was reacted with chlorine gas at elevated temperatures. Germanium tetrachloride and other volatile chlorides were condensed, and the germanium tetrachloride was separated in pure form by fractionation. The germanium tetrachloride was hydrolyzed to germanium dioxide and then reduced to germanium in a hydrogen furnace.

ABSTRACT NUMBER 65

PROGRESSIVE CRYSTALLIZATION PURIFICATION OF GERMANIUM

J. P. Jordan

UNTIL recently, difficulty in purification of metallic germanium has left the user completely dependent on the supplier of dioxide for the purity of the metal used. Fractional crystallization purification eliminates this dependency. Purifications of 10:1 can be achieved in a single run. Equipment used and results achieved will be discussed.

ABSTRACT NUMBER 66

ELECTRODEPOSITION OF GERMANIUM

G. Szekely

A PROCESS has been developed for electrodepositing a substantial layer of metallic germanium which adheres well. The plating bath is a solution of germanium tetrachloride in propylene glycol. It is conveniently operated at a temperature of 50°-60°C.

ABSTRACT NUMBER **66a**

PREPARATION AND SOME PROPERTIES OF HAFNIUM METAL

Felix B. Litton

RELATIVELY pure hafnium metal, 99 per cent hafnium, was produced by iodide deposition. The procedure consisted of chlorinating previously purified hafnium oxide at 950°C and reducing the tetrachloride in a sealed reactor with magnesium. The resulting sponge was acid leached and then iodide refined in glass and metal bulbs.

The following properties of hafnium metal were observed: density—13.09 g/cm³; melting point—2130°C; transformation temperature—no allotropic transformation was observed up to the melting point; lattice parameter—c is equal to 5.0422 Å, a is equal to 3.1883 Å, and c to a ratio is equal to 1.5815 Å; hardness—Vickers 152, Rockwell A43, Rockwell B78; malleability—30 per cent maximum cold reduction; recrystallization temperature—700°-800°C; oxidation in air—0.15 mm penetration at 950°C for two-hour period; chemical corrosion resistance—excellent but less resistant than zirconium metal in common reagents tested.

ABSTRACT NUMBER **67**

EFFECT OF PRESSURE ON THE REFINING OF LITHIUM BY DISTILLATION

R. R. Rogers and G. E. Viens

LITHIUM containing 0.5 per cent sodium can be refined by distillation in the presence of argon in a straight retort, the refined metal containing as low as 0.002 per cent sodium. At pressures up to 1 micron, the sodium content remains at 0.002 per cent. Between 1 and 740 microns, it is quadrupled. In the presence of argon, nitrogen, oxygen, and hydrogen at different pressures, in a slightly V-shaped retort, a sodium content of less than 0.01 per cent was not obtained. There was little evidence of oxide, nitride, or hydride formation at pressures of oxygen, nitrogen, or hydrogen below 35 microns.

ELECTRONICS—RARE METALS AND ELECTROTHERMICS

ABSTRACT NUMBER **68**

PRODUCTION OF HIGH TEMPERATURES BY THE COMBUSTION OF METALS*

A. V. Grosse and R. Miller

IN ORDER to attain extreme temperatures by means of chemical reactions, the following three conditions have to be met: (1) high exothermicity of the reaction; (2) high thermal stability of reaction products; and (3) high refractory properties of reaction products. An additional and practical consideration is the low price of suitable reactants. These conditions are fulfilled in the combustion of metallic aluminum and magnesium in oxygen, particularly under pressure.

These and other metals were successfully burned in stationary and centrifugal furnaces. At atmospheric pressure the calculated temperatures are in the range of 3500°-3800°K or 5800°-7200°F for magnesium and aluminum, and are higher at higher pressures. Fire loadings of approximately one million Btu per hour and ft^2 (or 150 million kcal/hr and m^2) have been attained.

The new method permitted the development of various apparatus for the range of 2000° to 3000°C (3600°-5400°F), for example, a mixer and a boiler.

* This research has been supported by ONR-Project N9-onr87300.

ABSTRACT NUMBER **69**

FUSION ELECTROLYSIS APPARATUS FOR THE PRODUCTION OF METAL BORIDES

S. J. Sindeband* and R. P. Seelig

THE apparatus described in this paper represents a further development of work originally described by Andrieux and was constructed with the primary purpose of providing reasonable quantities of metal borides for experimental purposes. The criteria were necessarily flexible

insofar as product and operation were concerned.

An interesting aspect of the apparatus is the method of heating of the bath in which the bath itself is the heating element through the use of superimposed alternating current energy.

Typical bath compositions and operating cycles are described.

* At the time this equipment was designed and first taken into operation, Mr. Sindeband was Technical Director of American Electro Metal Corporation and he now serves as a consultant of this company.

ABSTRACT NUMBER 70

THE ARC MELTING OF ZIRCONIUM SPONGE

H. L. Gilbert, W. A. Aschoff, and W. E. Brennan, II

IN ARC melting zirconium metal with a wolfram electrode, some wolfram appears in nonuniform amounts throughout the ingot. To eliminate this, we propose the use of consumable electrodes of zirconium sponge.

All early attempts to use sponge zirconium electrodes were unsuccessful due to instability of the arc. This problem is overcome by stabilizing the arc with a small amount of magnesium metal added to the zirconium sponge used in making up the electrodes.

A water-cooled copper sleeve is used as a melting section in the arc melting furnace. Melting is done under inert atmosphere of argon or helium.

Metallographic and radiographic studies show the finished ingots to be sound and clean.

ABSTRACT NUMBER 71

REMOVAL OF EMBRITTLING GASES FROM ZIRCONIUM

W. C. Lilliendahl, E. D. Gregory, and D. M. Wroughton

ATTEMPTS to reverse the reaction $Zr + O_2 = Zr$ (O_2 solution) have met with no success.

A practical process for removing dissolved oxygen from zirconium based on the mobility of this gas in the zirconium lattice at elevated temperatures is treated thermodynamically, and substantiated by analytical data on zirconium

metal analyzed for oxygen before and after processing.

A practical method is described for removing dissolved oxygen in the range 0.02—0.5 per cent. The final oxygen equilibrium value obtained is approximately 0.02 per cent based on time, temperature equilibrium studies.

Similar studies on dissolved nitrogen in zirconium show that a reduction in nitrogen content is not possible by the methods described.

ABSTRACT NUMBER **72**

INERT ATMOSPHERE ARC FURNACES FOR MELTING PURE METALS WITH PARTICULAR REFERENCE TO TITANIUM

W. E. Kuhn

FOR melting applications where contamination of the melt is prohibitive, the inert atmosphere arc furnace employing water-cooled copper crucibles is recommended. The design and operation of two furnaces of this kind are described, one of which employs a 2½ inch diameter crucible and another which employs either a 3 inch or 5 inch diameter crucible.

Beneficiation of titanium sponge by leaching and drying to improve its melting quality is described.

Water-cooled copper crucibles with graphite liners gave faster melting rates but contaminated the melt with carbon.

Experiments are described in which a-c arcs were stabilized with a superimposed h.f. high voltage current. Neither coated graphite tips nor tungsten tips could be used because of the high rate of electrode consumption.

ABSTRACT NUMBER **73**

DEVELOPMENT OF ELECTRODES FOR, AND THERMAL LOSSES IN, THE INERT ATMOSPHERE ARC FURNACE

W. E. Kuhn

PART I—Development of Electrodes

A TITANIUM-TiC coated graphite-tipped electrode was developed for melting titanium

without excessive carbon pickup. The principles evolved from the melting of titanium and zirconium may be extended to the development of graphite tips coated with other carbide-forming elements.

PART II—Thermal Losses

THE effect of varying arc length, arc current, and arc voltage on the steady-state heat losses in the cooling water supplied to the electrode, crucible walls, and crucible bottom were studied.

Electrode and bottom heat losses increased linearly with increasing current and amounted to about 10 and 4 per cent, respectively.

Heat extracted by the crucible walls amounted to about 80 per cent of the total power input. Short arc lengths and high arc currents tended to improve the melting efficiency.

Tungsten-tipped electrodes exhibited more efficient arc melting characteristics than graphite tips.

ELECTROTHERMICS

ABSTRACT NUMBER 74

ENERGY REQUIREMENTS OF ELECTRIC FURNACE PRODUCTS

G. R. Finlay

CURRENT power shortages have made pertinent an inquiry into the energy demands of electric furnace processes. The minimum requirements of power have been calculated for the fusion of oxides and for the synthesis of carbides. Previously published data on silicon carbide have been revised and corrected. Energy required is shown in kwhr/lb of product for the fusion of Al_2O_3, MgO, and ZrO_2; for the purification of Al_2O_3 from bauxite and ZrO_2 from zircon sand; and for the synthesis of TiC, ZrC, B_4C, SiC, and ferrosilicon from the appropriate oxides.

ABSTRACT NUMBER 75

PRODUCTION OF FUSED STABILIZED ZIRCONIA

D. W. Marshall

A METHOD for producing high-purity fused stabilized zirconium oxide is described in detail. The resultant product is used chiefly as a high temperature refractory, or as a thermal insulator. Ores and raw materials which have been used for the manufacture of these products are listed. Typical chemical compositions and properties of finished products are given.

ABSTRACT NUMBER 76

THE RELATIONSHIP OF ALPHA AND BETA SILICON CARBIDE

Henry N. Baumann, Jr.

IN A SERIES of experiments to form silicon carbide under various time-temperature conditions from mixtures of silica and carbon and from silicon and carbon, the products which were formed were examined by x-ray diffraction, and electron and optical microscopy, and chemical analysis. It was found that (*a*) primary silicon carbide (beta silicon carbide) could be formed at temperatures as low as 500°C when the silicon for the reaction was derived from a low melting silicon-lead alloy; (*b*) beta silicon carbide is stable to near 2100°C; (*c*) under certain experimental conditions beta silicon carbide showed no significant crystal growth when held for 44 hours at 1800°C and only small growth up to 2100°C; and (*d*) that the change from beta to alpha silicon carbide is monotropic, and is complete in a few minutes at 2300°C.

ABSTRACT NUMBER 77

EXPLORATION WITH THE HIGH TEMPERATURE MICROSCOPE

(A Motion Picture)

The Carborundum Company Research Staff
(through G. M. Butler)

THIS film in full color with music and narrative describes the special microscope used in the laboratory of The Carborundum Company for direct observation of phenomena taking place at temperatures up to at least 2500°C. Details of the optical system and related components are shown, followed by scenes taken through the

microscope. These include crystallization of titanium oxide from a glass; corrosion of selected refractories by glass; melting studies of materials such as alumina; the wetting of abrasive grains by bonding materials; sublimation and crystallization of alumina; and the direct observation of the formation of silicon carbide.

ABSTRACT NUMBER 78

REFRACTORY METAL BASE SUPER ALLOYS

Claus G. Goetzel and Robert L. Pettibone

ALLOYS containing extraordinary high percentages of tungsten or molybdenum can be produced by powder metallurgy, and the technique of infiltrating spongy skeleton bodies of these refractory metals with the well-known heat-resistant nickel and cobalt alloys leads to composite structures displaying properties related to the proportional representation of either phase.

The abundance of the heat-resistant alloy phase in the final structure results in a limited, though definite, ductility at 1800°F, indicating a lower creep rate than met in conventional heat-resistant alloys of comparable strength.

By prealloying the tungsten with chromium, a high degree of oxidation resistance up to 2200°F is attained in the infiltrated material.

The mechanism of infiltration is governed by physical and chemical conditions, and excessive solubility, concentration changes, and gassing impose difficulties in its practical control.

ABSTRACT NUMBER 79

VAPOR DEPOSITION OF METALS ON CERAMIC PARTICLES

James E. Cline and John Wulff

THE coating of ceramic particles with metal by vapor deposition was investigated for the production of high-temperature metal-ceramic bodies. Methods are described for coating particles of ceramics, such as silica, silicon carbide, and alumina, with molybdenum deposited by hydrogen reduction of molybdenum pentachloride vapor and with nickel deposited by thermal decom-

position of nickel carbonyl. During the coating process the particles must be kept in motion by gas flow or mechanical agitation. In the presence of titanium carbide the decomposition of nickel carbonyl was found to proceed abnormally, leading to the formation of carbon.

ABSTRACT NUMBER **80**

REFRACTORY BODIES COMPOSED OF BORON AND TITANIUM CARBIDES BONDED WITH METALS

James A. Nelson, Tracy A. Willmore, and Raymond C. Womeldorph

TITANIUM carbide and boron carbide each possess physical properties that are desirable in creating a light material that will retain its strength through rapid temperature changes and with use at sustained elevated temperatures (1500°F and above). In the present study, mixtures of these carbides, in a finely divided form, were compacted with several different metals and fired in an argon atmosphere at temperatures ranging from 3500° to 3750°F. The reactions occurring between the carbides and metals are discussed. On the basis of this investigation, compositions are selected which show the greatest promise for additional work and further evaluation by physical testing.

ABSTRACT NUMBER **81**

DESIGN PROPERTIES OF CEMENTED CARBIDE COMPOSITION

John C. Redmond and John W. Graham

THE combination of properties of cemented titanium carbide compositions are very different from that of the alloys which have been used for highly stressed and moving parts so that new study and data are necessary to apply the new materials. Stress to rupture and other data are reported for various cemented titanium carbide compositions and, in addition, the results of tests to determine the effects of stress concentration as would be encountered in engineering design. The application of these results to design is discussed.

ABSTRACT NUMBER **82**

TiC BASE CERMETS: OXIDATION AND STRUCTURE STUDY

Clinton C. McBride

A QUALITATIVE investigation of the degree of chemical reaction between TiC plus Cr, Fe, Co, or Ni, and several alloys was conducted by metallographic means. This study was made chiefly with specimens fabricated by powder metallurgy techniques. Specimens produced by impregnating TiC skeletons with molten Ni or a nickel-aluminum alloy were also studied.

A preliminary study was conducted on the stability of the sintered cermet structures at high temperatures to determine its effect on high-temperature strength.

The oxides formed on TiC base cermets and some TiN base cermets were studied to determine the factors controlling the oxidation mechanism.

ABSTRACT NUMBER **83**

THERMAL SHOCK RESISTANCE OF BRITTLE MATERIALS
I. General Theory

H. S. Levine and C. A. Domenicali

A THEORY of thermal shock resistance of brittle materials is presented for bodies in the shape of an infinite slab, an infinite cylinder, and a sphere. Basis for the theory is the assumption that failure occurs during heating or cooling when any of the thermal stresses, including shear, exceeds the strength of the body.

The influence on the thermal shock resistance of compressive, shear, and tensile strengths, modulus of elasticity, coefficient of expansion, thermal conductivity, thermal diffusivity, surface heat transfer coefficient, size, and time is examined in detail. It is shown that the thermal shock resistance of all three shapes approaches the same limiting value as size increases.

ABSTRACT NUMBER **84**

THE FABRICATION AND PROPERTIES OF Be_2C

John H. Coobs and Walter J. Koshuba

THE methods currently in use for the synthesis of beryllium carbide in commercial quantities are described, and the more important physical and chemical properties of this material are discussed.

The techniques used for its fabrication into useful bodies, such as conventional ceramic methods and powder metallurgical processes, are described in detail. Since beryllium carbide exhibits no appreciable plastic flow, and since it undergoes thermal decomposition at high temperatures where recrystallization would normally be expected, it is often necessary to incorporate with it other materials in order to achieve the necessary compaction and bonding.

Some physical properties of beryllium carbide bodies are tabulated for comparison in both the bonded and unbonded condition.

ABSTRACT NUMBER **85**

MECHANISM OF ADHERENCE OF CERAMIC COATINGS TO STEEL

W. N. Harrison

A REVIEW of the principal theories for adherence of porcelain enamels to steel is given. Current investigations on the mechanism of adherence at the National Bureau of Standards, sponsored by the National Advisory Committee for Aeronautics, are described. Recent results throwing new light on the subject are reported. The roles of cobalt and iron and their oxides in promoting adherence are being studied by autoradiographic methods, through which their distributions in the coating layer and interface, and their migrations, can be followed. The role of hydrogen is being studied by substitution of deuterium and its recovery with the mass spectrometer.

ABSTRACT NUMBER **86**

THE ZIRCONIA-YTTRIA SYSTEM

Pol Duwez, Frank H. Brown, Jr., and Francis Odell

THE phase relationships in the zirconia-yttria system have been established up to a temperature of 2000°C. The addition of 0 to 5 mole per

cent yttria lowers the temperature at which zirconia transforms from the tetragonal to the monoclinic form. From 7 to 55 mole per cent, yttria is soluble in zirconia and this solid solution is cubic (stabilized zirconia). The mechanism of stabilization of zirconia by an oxide of the yttria type is discussed in relation to the crystal structure of these two oxides. It is concluded that scandia, as well as other oxides of the rare earth group from element 62 to element 71, should stabilize zirconia by the same mechanism. Experimental results obtained on scandia, gadolinia, and samaria confirm this prediction.

ABSTRACT NUMBER **87**

THE DEVELOPMENT AND TESTING OF HIGH-TEMPERATURE OXIDE REFRACTORIES — BERYLLIA-ALUMINA-TITANIA PORCELAINS

S. M. Lang

ALUMINUM titanate bodies are known to have a low linear expansion in the range of room temperature to 1000°C. It was hoped that the high thermal conductivity of beryllium oxide could be combined with the low expansion of aluminum titanate in order to develop a ceramic material for the replacement of metallic and alloy components in various high-temperature power plants such as jet engines, gas turbines, rockets, and for various nuclear power applications. The development of beryllia-alumina-titania refractory porcelains are discussed in conjunction with the present state of knowledge of pure oxide porcelains and their physical properties.

ABSTRACT NUMBER **88**

THERMOCOUPLES FOR MEASURING TEMPERATURE UP TO 4000°F

Gary Steven

THE increasing industrial and military application of very high temperature operations has created a need for thermocouples to operate continuously at 3000°F plus. The different uses

have placed diverse requirements on the performance of thermocouples and created a challenge in trying to meet these specifications. The present status of development and the need for further research will be discussed.

ABSTRACT NUMBER **89**

KEEPING INDUSTRIAL OPTICAL PYROMETERS IN CALIBRATION

Guy H. Fetterley

THE plan described can be used in plant or laboratory for routine checking of operating pyrometers against a standard pyrometer. It features broad filament lamps in a convenient mechanical assembly, and the use of the radiation laws to minimize wear and tear on the standard pyrometer.

ABSTRACT NUMBER **90**

EMISSIVITY IN OPTICAL PYROMETER MEASUREMENTS

R. C. Machler

THIS paper discusses the use of the following devices and/or techniques: (1) special absorption screens for the direct reading of true temperatures with the optical pyrometer; (2) auxiliary illumination to obtain black body conditions for true temperature measurement where the emissivity is unknown and/or variable; and (3) illumination in the optical pyrometer measurement of fine filament temperatures.

ABSTRACT NUMBER **91**

THERMOMETRY BY MEASUREMENT OF ELECTRICAL NOISE

J. B. Garrison

WORK at the University of Chicago Institute for the Study of Metals led to a method for

determining the ratio of two absolute temperatures to an accuracy of 0.1 per cent. The measurement is made by balancing the random electrical noise from two resistors and simultaneously comparing their resistances. The ratio of the two resistances is then equal to the ratio of the absolute temperatures of the two resistors. This paper outlines the basic principles, discusses operating difficulties, and considers the possible future use of this technique at high temperatures.

ABSTRACT NUMBER **92**

THE MEASUREMENT OF FLAME TEMPERATURES

R. D. Arnold

VARIOUS optical techniques used in the measurement of flame temperatures, practical limitations of each method, and precautions to be observed in the engineering use of gas temperatures will be discussed.

ABSTRACT NUMBER **93**

MAINTENANCE OF THE HIGH-TEMPERATURE SCALE AT THE NATIONAL BUREAU OF STANDARDS

R. J. Corruccini

THE International Temperature Scale of 1948 is maintained at the NBS through use of a standard optical pyrometer, the calibration of which is based on Planck's law of radiation and direct observation of the freezing point of gold. The calibrations of ribbon-filament lamps, radiation pyrometers, thermocouples, or other optical pyrometers—all of which may be used as secondary standards—are ultimately derived from comparison, direct or indirect, with the standard optical pyrometer. Possible differences between the International Temperature Scale and the thermodynamic or Kelvin scale in the range above 1063°C, as well as the application of the noise thermometer at the NBS to the elucidation of the differences, are discussed.

ABSTRACT NUMBER 94

THE ROLE OF THE CATION IN THE ELECTRICAL DOUBLE LAYER

David C. Grahame

THE differential capacity of a number of tenth-normal aqueous solutions of metallic chlorides has been measured as a function of potential. The results are interpreted to mean that the solvent sheaths on the positive and negative ions are displaced as the ions approach the interface. New explanations are given for several well-known phenomena connected with the double layer. The surface charge density and integral capacity of the nondiffuse part of the electrical double layer have been calculated from these data. The ratios of the differential capacities have been found to approach unity at potentials where the concentration of cations within the double layer is at a minimum.

ABSTRACT NUMBER 95

STUDIES ON ELECTRODE PROCESS OF METALS

R. Piontelli

AFTER a summary of definitions required in the study of electrode processes, and a discussion of electrode overvoltages, the theory of the metal ion exchange processes is developed from the point of view of thermodynamics and statistics. Details of the experimental methods are discussed, and the qualitative aspects of the results briefly summarized on the basis of the structural properties of metallic and liquid phases.

The influence of the solvent, and hydrogen and oxygen, are briefly discussed, while the influence of anions is covered in greater detail.

ABSTRACT NUMBER 96

THERMODYNAMICS AND KINETICS OF ELECTROLYTIC DEPOSITS LESS THAN A MONOATOMIC LAYER

M. Haissinsky

THE problem of the measurement of critical potentials of deposition of ions in extremely dilute solutions is reviewed and discussed critically. Experimental data are given for polonium, bismuth, lead, silver, zinc, and protactinium, including original measurements.

It is shown that the results obtained agree in certain cases with the Nernst equation for solutions as dilute as $3 \times 10^{-10}N$, and that the heterogeneity of the surface is an essential factor in establishing the potentials. The assumption of the occurrence of "active spots" on the electrodes and exponential distribution of these offers explanation for the experimental data. The analogy between these electrolytic processes and the adsorption of gases is discussed.

ABSTRACT NUMBER 97

ELECTRODEPOSITION BEHAVIOR OF TRACES OF SILVER

II. Effects of Electrode History and Presence of Other Ions

John C. Griess, Jr., John T. Byrne, and L. B. Rogers

THE behavior of amounts of silver forming less than a monolayer on an inert electrode has been determined in the presence of several ions. Relatively large amounts of copper (II), palladium(II), and platinum(IV) were without effect but hydrogen ions produced a significant effect. The importance of electrode history was demonstrated in an interlaboratory comparison and means of minimizing the resulting differences were examined.

ABSTRACT NUMBER 98

ELECTRODEPOSITION BEHAVIOR OF TRACES OF SILVER

III. Transition Region Between "Trace" and "Macro" Behavior

John T. Byrne, L. B. Rogers, and John C. Griess, Jr.

CURVES for the amount of silver deposited versus the potential were found to be complex. Instead of a simple S-shaped curve, the curves

usually had one or more plateaus. These plateaus were found with platinum, palladium, and gold electrodes.

ABSTRACT NUMBER 99

CRITICAL INTERPRETATION OF ELECTRODEPOSITION STUDIES INVOLVING TRACES OF ELEMENTS

John T. Byrne and L. B. Rogers

RECENT experiments have confirmed the postulate of Haissinsky that the deposition behavior of traces of metals is affected by the heterogeneity of the surface. Most of the experimental data can be explained on this basis without making the further assumption that discrete "active centers" are necessary. One can write a simple thermodynamic expression for the amount deposited as a function of potential which describes most of the experimental results.

ABSTRACT NUMBER 100

THE ELECTROCHEMISTRY OF THE FIRST LAYERS OF ELECTRODEPOSITED METALS

T. Mills and G. M. Willis

THE electrolytic deposition of the first few atomic layers of a number of metals on gold and silver has been studied by the well-known method of charging curves. Preliminary results have indicated the value of the method for studying the first stages of electrodeposition; in particular, the variations in the nature of the binding of the first atomic layers to the basic metal have been revealed.

ABSTRACT NUMBER 101

RESIDUAL CURRENTS

Edgar Newbery

A STUDY of the small currents flowing between two unattackable electrodes when subjected to a potential difference less than the decomposition potential of the electrolyte has revealed a highly complex system. Part of this current is

reversible and due to the formation and charging of condensers, and to solution of gases at low pressures in electrode and electrolyte, but a much larger part is irreversible, and though a small fraction of this part may be due to diffusion of gases, most of it appears to be due to electronic and not to electrolytic conduction.

ABSTRACT NUMBER 102

THE ANODIC DECOMPOSITION OF HYDROGEN PEROXIDE

A. Hickling and W. H. Wilson

ANODIC decomposition of hydrogen peroxide has been investigated over a wide range of conditions. At all the anode materials investigated, hydrogen peroxide is quantitatively decomposed, in accordance with the equation $H_2O_2 + 2f = 2H^+ + O_2$. In alkaline solution, the common process can be formulated as $HO_2^- - 2e = H^+ + O_2$; this takes place rapidly and, in general, is governed by diffusion. In neutral and acid solutions, this process does not take place appreciably but rather as an interaction of the OH radical with the H_2O_2 molecule. Platinum anodes in neutral and acid solutions show a specific behavior attributed to chemical interaction of hydrogen peroxide with platinous oxide.

ABSTRACT NUMBER 103

BRIGHT NICKEL PLATING ON METALLIC SINGLE CRYSTALS IN THE ABSENCE OF ADDITION AGENT

Henry Leidheiser, Jr., and Allan T. Gwathmey

NICKEL was electrodeposited from a Watts bath on electrolytically polished single crystal spheres of copper and nickel under a wide variety of experimental conditions. The deposit which formed on the (100) faces remained mirror-bright and monocrystalline to thicknesses of the deposit as great as 0.01 inch. The deposit which formed on the (111) faces was matte and polycrystalline from the very start of deposition. The following characteristics associated with the two types of deposits were compared: composition by spectrographic analysis, current density and current efficiency during deposition, hardness, ductility, porosity, and corrosion resistance. The results may have application in the growth of nickel single crystals by electrodeposition.

ABSTRACT NUMBER 104

A THEORETICAL STUDY OF THE JUNCTION BETWEEN ANODIC AND CATHODIC POLARIZATION CURVES AND OF MIXED POTENTIALS

Pierre Van Rysselberghe

THE junction of anodic and cathodic polarization curves is studied mathematically on the basis of Tafel expressions.

The point of maximum curvature is determined and proposed as characterizing the transition from slow to rapid increase of current. The mixed potentials resulting from simultaneous reactions on the same electrode are calculated for different relative positions of the reversible anodic and cathodic potentials.

ABSTRACT NUMBER 105

THE KINETICS OF OXIDATION-REDUCTION ELECTRODE REACTIONS

J. V. Petrocelli

A DISCUSSION of the kinetics of oxidation-reduction electrode reactions is presented. It is shown that the electrode reactions may be treated as rate processes and a general expression for the electrode potential-current density relationship is derived. This equation shows how the polarization curves may behave under conditions where concentration overvoltage and activation overvoltage are involved. It is suggested that the use of this equation may allow such important factors as "exchange current" and "transfer coefficients" to be evaluated and thus contribute to our knowledge of electrode reaction mechanisms.

ABSTRACT NUMBER 106

OVERVOLTAGE AT OXIDATION-REDUCTION ELECTRODES

J. V. Petrocelli and A. A. Paolucci

AN EXPERIMENTAL study has been made of the polarization characteristics of the follow-

ing oxidation-reduction electrode systems: iron sulfate, iron chloride, potassium ferrocyanide-ferricyanide, and cerium sulfate. Data are presented which strongly indicate that the overvoltage includes an activation overvoltage in addition to that due to concentration polarization. The data are analyzed from the point of view of rate processes and it is shown that the electrode behavior is given by an equation which allows an evaluation of the exchange current density and the transfer coefficients.

ABSTRACT NUMBER 107

THE MECHANISM OF THE HYDROGEN EVOLUTION REACTION

J. O'M. Bockris and E. C. Potter

A CRITICAL review of modern experimental studies is given, including the theory of the dependence of i_o, the exchange current, upon Φ, the thermionic work function. The problem of obtaining a reproducible, oxide-free surface is discussed.

Deductions are presented for the general equations of the velocity of hydrogen evolution as a function of potential, time, and temperature, as well as diagnostic criteria, particularly those connected with the salt effect. The kinetics of consecutive reactions and the effect of potential upon the rate of atomic hydrogen combination are considered.

The diagnostic criteria considered are applied to the available experimental data.

ABSTRACT NUMBER 108

HYDROGEN OVERVOLTAGE FROM THE KINETIC-THERMODYNAMIC VIEWPOINT

Hugh W. Salzberg

FROM thermodynamic and kinetic considerations, an equation for overvoltage is derived in which $V = -RT/mF \ln K + RT/mF \ln i$, where i is the current density, m is the order of the rate determining equation, and K its rate constant.

The rate determining step is considered to be either the combination of atoms to form molecules, the desorption of atoms, or the formation

and subsequent decomposition of hydrides, depending on the metal involved, the temperature, and the applied voltage.

On this basis, an attempt is made to explain some of the complex phenomena of overvoltage.

ABSTRACT NUMBER **109**

SOME FACTORS IN ANODIC PROCESSES ON CORRODING METALS

T. P. Hoar and U. R. Evans

MANY alloying elements which confer resistance to high-temperature oxidation also prevent low-temperature corrosion; they produce films which only slowly transmit cations. Conversely sulfur, which introduces lattice defects and thus favors the transmission, accelerates high-temperature oxidation and favors the onset of low-temperature corrosion. A rapid supply of dissolved oxygen to all parts of the metallic surface may arrest metallic cations as they emerge, thus thickening the film and preventing corrosion; a far more rapid supply of oxygen is needed to prevent corrosion on iron or zinc than on stainless steel, but the supply needed is diminished if an inhibitor is present.

ABSTRACT NUMBER **110**

THE INFLUENCE OF INHIBITORS ON THE DISSOLUTION OF IRON IN ACID SOLUTION

J. Elze and H. Fischer

INHIBITORS which affect the reaction of iron with hydrochloric acid differ in the mechanism of their action. They increase the metal-solution overvoltage only slightly, but considerably raise the hydrogen overvoltage. Inhibitors, otherwise effective, have little influence on the reduction of ferric ions at a platinum cathode. At an iron cathode, ferric ions are reduced primarily by hydrogen, which inhibitors activate. Inhibitors are effective in the dissolution of iron only if the reaction $MeH + MeH \rightarrow H_2 + 2Me$ is possible. This explains the relatively slight effect of inhibitors on the dissolution of iron in the presence of oxygen.

ABSTRACT NUMBER 111

THE STRUCTURE OF METAL DEPOSITS OBTAINED BY ELECTROCHEMICAL DISPLACEMENT UPON ZINC

M. E. Straumanis and C. C. Fang

IT WAS found that Cu, Au, Ni, and Ag deposits, obtained by electrochemical displacement from their salt solutions in 1*N* sulfuric acid upon zinc, were not pure, but contained Zn in appreciable amounts. It could be shown by x-ray analysis that zinc formed solid solutions with the metals mentioned, except Ag. The grain size of the deposits was very small because their growth was hampered by codeposited Zn. The reasons for the redeposition of Zn by its own emf are discussed.

ABSTRACT NUMBER 112

PHASE BOUNDARY POTENTIALS OF SILVER IN FOREIGN ION SOLUTIONS IN THE COMPLETE ABSENCE OF AIR

J. H. Rosenbaum and D. MacGillavry

PHASE boundary potentials of metals in contact with solutions free from common metal ions have been reported in several publications. The extensive work on mercury-foreign ion systems by Erdey-Gruz and Szarvas is well known. Analogous to their work, the behavior of silver has been investigated in potassium bromide solutions. The metal was degassed in high vacuum at temperatures close to the melting point, and the solutions were freed from oxygen in a stream of purified nitrogen. The potentials were measured with an electrometer as a null point indicator.

Stationary potentials were obtained which in the more concentrated bromide solutions were more negative than the silver-silver bromide potentials in air. The possible mechanisms by which these metal-solution potentials may be established are being examined.

ABSTRACT NUMBER 113

ANODE POLARIZATION EFFECTS OF NICKEL IN SULFURIC ACID

Dennis R. Turner

THE electrochemical polarization effects at nickel anodes in $2N$ sulfuric acid were studied to determine the nature of the electrode reactions involved. Current densities below and above that required to passivate a nickel anode were used. There was evidence of an anodic film forming at the active nickel surface prior to the onset of passivity. In the passive state, the anode reaction was the discharge of hydroxyl ions and subsequent evolution of oxygen gas and formation of a nickel oxide. The presence of chloride ions had the effect of raising the minimum current density required to passivate a nickel anode and delaying the onset of passivity above this current density. The nickel oxide formed anodically was soluble in the acid solution and controlled the rate of polarization decay.

ABSTRACT NUMBER **114**

CATALYTIC HYDROGEN-DEUTERIUM EXCHANGE ON DIFFERENT CRYSTAL FACES OF IRON

Ling Yang

THE catalytic activities of different iron catalysts in hydrogen-deuterium exchange reaction have been studied and are found to be in the order $S(110) < S(100) < P(110) < P(r) < P(111)$, where $S(100)$ represents an approximate (100) face of an iron single crystal, $S(110)$ single crystal (110) facets developed by electrodeposition of iron on $S(100)$, and $P(110)$, $P(111)$, and $P(r)$ polycrystalline electrodeposits of iron having (110) orientation, (111) orientation, and random structure, respectively. At 533°K the approximate ratio is $(<0.34):1:40:300:400$. The activation energies on the single crystal faces are nearly constant over a wide range of temperature. Crystal-boundary regions appear to be favorable locations for active centers.

ABSTRACT NUMBER **115**

POTENTIALS OF CELLS WITH LIQUID-LIQUID JUNCTIONS

David C. Grahame and J. I. Cummings

Potentials of cells of the type

Ag, AgCl, M_1Cl (C = $0.1N$) M_2Cl (C = $0.1N$), AgCl, Ag

have been measured. The results are roughly in

agreement with the demands of the Henderson equation for liquid junction potentials but disagree with the results of previous investigators wherever potassium chloride was one of the electrolytes employed. The disagreement is attributed to experimental error in previous determinations. A re-examination of the theoretical foundations of the Henderson equation shows that it is more properly regarded as relating to the potentials of *whole cells* containing the liquid junction in question. A similar remark applies to the Lewis and Sargent equation.

ABSTRACT NUMBER 116

HYDROGEN CYANIDE DETECTION WITH THE SILVER ELECTRODE

H. H. Roth

AN APPARATUS for the determination of low concentrations of hydrogen cyanide in air is shown. Both continuous operating and portable type apparatus are described in detail. A calibration curve for 1 to 1000 parts per million hydrogen cyanide in air is given. A precision of ± 10 per cent is demonstrated. Hydrogen sulfide detection with the apparatus is possible by merely a recalibration.

ABSTRACT NUMBER 117

THE APPLICATION OF THERMODYNAMICS TO THERMOGALVANIC DATA

(A Study of the Silver Chloride Electrode from 25° to 100°C)

Harry Levin and Charles F. Bonilla

THERMOGALVANIC data may find application in the approximate determination of thermodynamic constants; in the measurement of concentration changes in industrial processes; and in the delineation of corrosion situations.

Ag/AgCl thermogalvanic cell data were obtained at cell temperature gradients from 0° to 65°C. It was found that the electrolyte species and concentration influenced the value of standard emf calculated from the measured potentials.

ABSTRACT NUMBER **118**

A POTENTIOMETRIC STUDY OF THE INTERACTION OF ZINC IONS WITH SODIUM SILICATES

J. Fred Hazel, Wallace M. McNabb, and Paul E. Machemer

ZINC SULFATE, zinc chloride, and zinc nitrate were titrated potentiometrically with standard solutions of sodium hydroxide, sodium orthosilicate, sodium metasilicate, and a more silicious silicate corresponding to the composition, $Na_2O \cdot 3.28SiO_2$. The potentiometric curves with sodium hydroxide showed inflections equal to between about 75 per cent and 100 per cent of the zinc present depending on the nature of the anion in the system. With zinc sulfate the break occurred when about 75 per cent of the zinc had been neutralized, corresponding to the basic salt, $ZnSO_4 \cdot 3Zn(OH)_2$.

The titration curves obtained with the above silicates showed points of inflection at 100 per cent to 110 per cent equivalents of base depending on the silica content of the silicate. The silicic acid present as a hydrolysis product stabilized the system and prevented the formation of basic zinc sulfate. Addition of other colloidal materials, gelatin, silica gel, and a silica sol, caused the point of inflection to shift from 75 per cent equivalents to higher values.

ABSTRACT NUMBER **119**

PRODUCTION OF OZONE WITH REFRIGERATED ANODES

E. I. Lash, R. D. Hornbeck, G. L. Putnam, and E. D. Boelter

BY ELECTROLYSIS of 40 weight per cent perchloric acid with refrigerated platinum metal anodes, electrolytic ozone of 58 weight per cent concentration has been prepared at energy efficiencies up to 24 grams ozone per kwhr. Maximum yields of ozone were attained with the internally cooled anode at −60° to −65°C, perchloric acid electrolyte at a bulk electrolyte temperature of −56°C, current density of 0.13 to 2.6 amp/dm², and a total pressure above the electrolyte of 10-100 mm Hg.

Ozone current efficiency, weight per cent ozone, and grams of ozone per kwhr increase with de-

creasing anode and electrolyte temperatures, and with increasing current density.

ABSTRACT NUMBER **120**

THE DEPOSITION OF COPPER POWDER WITH CONTROLLED CATHODE POTENTIAL

G. L. Putnam and J. D. Shepard

THE cathode potential—a function of the copper ion concentration at the side of the electrode reaction—was found to be a most important variable in determining the properties of electrodeposited copper.

The desirability of using the cathode potential to control the deposition of copper powder from copper sulfate-sulfuric acid solutions is discussed from the standpoint of achieving closer product control and facilitating cell design.

Apparatus used to maintain a constant cathode potential is described and the results of an investigation of the effect of varying conditions in the cell at constant potential are presented.

FALL MEETING

at the

STATLER HOTEL

Detroit, Michigan

October 10, 11, 12, and 13, 1951

SESSIONS ON

Corrosion

Electrodeposition

Organic Electrochemistry

Abstracts for the Fall Meeting (not exceeding 75 words in length) are due at the Secretary's Office, 235 West 102nd Street, New York 25, N. Y. not later than August 1, 1951

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INDEX TO AUTHORS

	Page
Anderson, J. T.	12, 40
Arnold, R. D.	17, 58
Aschoff, W. A.	14, 48
Baker, R. F.	13, 42
Bastian, Robert	11, 36
Baumann, Henry N. Jr.	15, 51
Beachell, Harold C.	7, 23
Bechtold, J. H.	13, 43
Birx, Donald L.	6, 22
Bockris, J. O'M.	19, 64
Boelter, E. D.	20, 69
Bonilla, Charles F.	20, 68
Bowers, Robert C.	8, 27
Brennan, W. E. II	14, 48
Brown, Frank H. Jr.	16, 55
Bull, C.	10, 34
Burnham, J.	7, 25
Butler, G. M.	15, 51
Butler, Keith H.	10, 12, 32, 39
Byland, L. D.	7, 24
Byrne, John T.	18, 60, 61
Byron, E. S.	13, 42
Callinan, Thomas D.	9, 30
Claffy, Esther W.	12, 40
Cline, James E.	16, 52
Connor, John A.	8, 25
Coobs, John H.	16, 54
Corruccini, R. J.	17, 58
Crater, C. D.	7, 25
Cummings, J. I.	20, 67
Deer, Leon L.	6, 22
Dikhoff, J. A. M.	11, 35
Domenicali, C. A.	16, 54
Dowling, P. H.	12, 39
Dropkin, J. J.	11, 35, 36
Duwez, Pol	16, 55
Dzimianski, John	7, 23
Elze, J.	19, 65
Eros, Stephen	10, 34
Evans, U. R.	19, 65
Fang, C. C.	19, 66
Fehr, E. B.	9, 30
Fetterley, Guy H.	17, 57
Few, W. E.	13, 42
Finlay, G. R.	15, 50
Fischer, H.	19, 65
Fischler, S.	11, 36
Foster, L. W.	7, 24
Froelich, H. C.	11, 36
Gall, John F.	8, 27
Garlick, G. F. J.	10, 34
Garrison, J. B.	17, 57
Georgiev, Alexander M.	7, 24
Gilbert, H. L.	14, 48
Ginther, Robert J.	10, 32, 33
Goetzel, Claus G.	15, 52
Goldstein, B.	11, 35
Graham, John W.	16, 53
Grahame, David C.	18, 20, 59, 67

	Page
Green, G.	7, 25
Gregg, C. C.	13, 43
Gregory, E. D.	14, 48
Griess, John C. Jr.	18, 60
Grosse, A. V.	14, 47
Gwathmey, Allan T.	19, 62
Haase, A. P.	9, 30
Haissinsky, M.	18, 59
Hall, Ralph	9, 28
Hannaford, Virginia M. B.	10, 32
Harrison, W. N.	16, 55
Hazel, J. Fred	20, 69
Henderson, S. T.	11, 38
Hickling, A.	18, 62
Hoar, T. P.	19, 65
Hornbeck, R. D.	20, 69
Hushen, C. J.	7, 24
Jaffee, R. I.	13, 44
Jerome, Charles W.	10, 12, 34, 39
Jordan, J. P.	14, 45
Kelly, John C. R.	13, 44
Klick, Clifford C.	10, 11, 33, 37
Kopelman, B.	13, 43
Koshuba, Walter J.	16, 54
Krilanovich, N. J.	8, 26
Kroeger, F. A.	11, 35
Kuhn, W. E.	15, 49
Lang, S. M.	16, 56
Larson, E. P.	13, 43
Lash, E. I.	20, 69
Leidheiser, Henry Jr.	19, 62
Leonard, John M.	7, 22
Levin, Harry	20, 68
Levine, H. S.	16, 54
Lilliendahl, W. C.	14, 48
Litton, Felix B.	14, 46
Lui Wei, C. K.	10, 12, 32, 41
MacGillavry, D.	20, 66
Machemer, Paul E.	20, 69
Machler, R. C.	17, 57
Mager, Eric L.	12, 39
Manning, G. K.	13, 42
Margolis, J. M.	11, 36
Marshall, D. W.	15, 50
McBride, Clinton C.	16, 54
McClinton, A. T.	9, 29
McNabb, Wallace M.	20, 69
Miller, R.	14, 47
Mills, T.	18, 61
Muriset, Gaston	8, 26
Nagy, Rudolph	10, 12, 32, 41
Nelson, James A.	16, 53
Newbery, Edgar	18, 61
Norton, James J.	9, 31
Odell, Francis	16, 55
Oszy, Alexander J.	10, 12, 33, 39
Ozarow, V.	13, 45
Palilla, Frank	11, 36
Paolucci, A. A.	19, 63

Page

Parke, Robert 13
Payne, Elmer C. 12, 39
Petrocelli, J. V. 19, 63
Pettibone, Robert L. 15, 52
Piontelli, R. 18, 59
Pitzer, J. C. 6, 21
Potter, E. C. 19, 64
Prener, Jerome S. 11, 38
Putnam, G. L. 20, 69, 70
Ranby, P. W. 11, 12, 38, 40
Rector, Clinton 9, 31
Redmond, John C. 16, 53
Rightmire, B. 13, 42
Robinson, P. 7, 25
Rogers, L. B. 18, 60, 61
Rogers, R. R. 14, 46
Rosenbaum, J. H. 20, 66
Roth, H. H. 20, 68
Ruscetta, R. A. 7, 24
Salzberg, Hugh W. 19, 64
Sass, S. 7, 24
Schulman, James H. 10, 12, 33, 40
Schumacher, J. G. 11, 37
Scott, H. 13, 43
Scribner, Bourdon W. 8
Seaman, E. F. 9, 30
Seelig, R. P. 14, 47
Sewell, J. R. 12, 39
Shepard, J. D. 20, 70
Sindeband, S. J. 14, 47
Skow, Norman A. 6, 21
Smith, Arthur L. 11, 12, 37, 41
Steven, Gary 16, 56
Stokes, R. G. 11, 37
Straumanis, M. E. 19, 66
Szekely, G. 14, 45
Szilard, J. A. 9, 28
Taylor, R. L. 8, 27
Temple, William M. 9, 29
Thorp, Clark E. 7, 23
Troxel, David I. 8, 26
Turner, Dennis R. 20, 66
Van Rysselberghe, Pierre 19, 63
Viens, G. E. 14, 46
Vore, M. P. 7, 22
Waters, J. E. 9, 28
Weaver, Jesse M. 9, 28
Weberling, Richard 11, 36
Weiss, Marguerite G. 13, 44
Wells, R. S. 12, 40
Whitehead, M. 8, 27
Willis, G. M. 18, 61
Willmore, Tracy A. 16, 53
Wilson, W. H. 18, 62
Wollentin, R. W. 10, 12, 32, 41
Womeldorph, Raymond C. 16, 53
Wroughton, D. M. 15, 48
Wulff, John 13, 16, 42, 52
Yang, Ling 20, 67

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